DS-01097
(Replaces DS-01043)

Iowa Department of Transportation

DEVELOPMENTAL SPECIFICATION
FOR
SANITARY SEWER

Effective Date
July 17, 2007

THE STANDARD SPECIFICATIONS, SERIES 2001, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE DEVELOPMENTAL SPECIFICATIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

This Developmental Specification is a rewrite. Please read carefully.

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The applicable sections of the Urban Standard Specifications for Public Improvements (SUDAS) have been included and modified in this Developmental Specification.

The applicable figures referenced in this Developmental Specification are included on the plans.

DIVISION 3 - TRENCH, BACKFILL, AND TRENCHLESS

SECTION 3010 - TRENCH AND BACKFILL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Trench excavation for pipe systems, utility accesses, intakes, and other structures.

B. Trench bedding and foundation stabilization.

C. Pipe and structure placement and backfill.

1.02 DESCRIPTION OF WORK

A. Perform all excavations required to complete the work shown in the plans.

B. Prepare trench excavations and shoring for new work, and install the utility lines, structures, and system components, including bedding and foundation stabilization.

C. Complete specified backfill operation.

1.03 SUBMITTALS

A. Samples, granular bedding material: submit 10 pound (5 kg) samples of each type, if required.

B. Samples, granular backfill material: submit 10 pound (5 kg) samples, if required.

C. Gradation reports for fill materials and bedding materials, if required.

D. Results of Proctor and In-Place Density Tests on backfill.

E. Provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Obtain approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.

B. Remove unsuitable and excess materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage

structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

B. Use of Explosives: Submit detailed plans outlining all proposed blasting operations, locations, methods, and use of mats and other safety measures to the Engineer.

1. Obtain written approval before using explosives.

2. Use personnel experienced with explosives.

C. Abandoned Utilities: Remove and dispose of abandoned utility lines including gas mains, water mains, sewer mains, telephone conduits, service lines, etc. required to complete the work. Said work shall be incidental to the project unless otherwise specified.

1.08 MEASUREMENT FOR PAYMENT

A. General: No separate payment will be made for unclassified excavation. Trenching, Bedding, Backfilling, Compaction, and Dewatering shall be included in the costs in the contract unit price for all pipe and structures, except as follows:

1. Rock Excavation: Rock, if encountered and verified by the Engineer, will be measured by the Engineer and paid for by the cubic yard (cubic meter) removed from the excavation, or will be paid for according to Article 1109.03, B of the Standard Specifications unless otherwise provided for in contract documents.

2. Over-excavation and trench bottom stabilization:

- **a.** Authorized over-excavation and trench stabilization will be measured by the cubic yard (cubic meter) removed.
- **b.** The quantity of stabilization material placed in the over-excavation will be measured in tons (kilograms).
- **c.** Payment will be made for over-excavation, stabilization material, and placement on the basis of the contract unit price or according to Article 1109.03, B, of the Standard Specifications.

3. Unsuitable Backfill:

- **a.** Where excavated material is found to be unsuitable for backfill and cannot be made suitable in the opinion of the Engineer, the Engineer will measure replacement material furnished by Contractor from outside the project limits by cubic yards (cubic meters), furnished, transported, and properly installed. Payment will be made at the contract unit price per cubic yard (cubic meter) or according to Article 1109.03, B, of the Standard Specifications.

b. Except for over-excavation, removal of unsuitable soil shall be considered as incidental to unclassified excavation.
c. If suitable backfill replacement material is within the project limits, it will not be measured and paid for separately.

B. Open Cut Casing and Carrier Pipe Installation: The length of properly installed casing will be measured along the centerline of the casing. Payment will be made for both the carrier pipe and casing pipe as a combined single bid unit for the appropriate method of installation.

C. Incidental Items: Unless otherwise stated in the contract documents, the following items will be included in the unit price for open cut casing and carrier pipe installation: guides, fillers, levels, backfill, and other appurtenances necessary to perform specified function.

D. Over-Excavation not for Stabilization and Repair of Same: No payment will be made.

E. Structure Removal: The Engineer will count the quantity of structures to be removed including each utility access and inlet removed in accordance with the plans. Payment will be for the number removed.

F. Surfacing Removal and Replacement: Unless otherwise specified in the contract documents all temporary or permanent surface removals and replacements for both granular and hard surfaces for streets, drives, and sidewalks will be included in the contract unit prices for all pipe and structures.

G. Abandoned Utilities: Remove and dispose of abandoned utilities within the work zone. This work shall be considered incidental to the contract unit price for pipes and structures.

H. Compaction Testing: All contractor provided services associated with compaction testing shall be considered incidental to the pipe installation.

PART 2 - PRODUCTS

2.01 EXCAVATED MATERIALS

A. Unclassified Excavation: Excavation of all materials encountered, except rock and over-excavation.

B. Rock Excavation: Boulders or sedimentary deposits that cannot be removed without continuous use of pneumatic tools or blasting.

C. Over-Excavation: Excavation of soil or rock in trenches below the pipe zone, see Figure 3010.1 on the plans.

D. Suitable Excavated Materials for Backfill:

1. Soil, clay, silt, sand, and gravel with moisture content suitable to achieve required compaction. ASTM D 2321, Class II through IVA (see Section 3010, 2.01 E of this Developmental Specification).

2. Fine-grained soils according to ASTM D 2321 Class IVB (inorganic) (see Section 3010, 2.01, E of this Developmental Specification) may be used in the final backfill upon approval of the Engineer.

3. Adjust moisture content of excessively wet, but otherwise acceptable material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.

4. Adjust moisture content of excessively dry, but otherwise acceptable material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.

5. Lime or fly ash may be added to earth material to produce a suitable backfill material. Uniformly mix soil and additive. Determine Standard Proctor maximum density and optimum moisture content of the modified material. Amount of additive applied is subject to the Engineer's approval.

E. Non-Manufactured (Excavated) Backfill Materials: (see Sections 3010, 2.03 and 2.04 of this Developmental Specification for manufactured backfill).

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (37.5 mm)	No. 4 (4.75 mm)	No. 200 (75 μm)	LL	PI	Uniformity C_u	Curvature C_c
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines	100%	‹50% of "Course Fraction"	‹5%	Non Plastic		›4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						‹4	‹1 or ›3
		SW	Well-graded sands and gravelly sands; little or no fines.		›50% of "Coarse Fraction"				›6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						‹6	‹1 or ›3
	Coarse-Grained Soils, borderline clean to w/fines	e.g. GW-GC, SP-SM	Sands and gravels that are borderline between clean and with fines.	100%	Varies	5% to 12%	Non Plastic		Same as for GW, GP, SW and SP	
III	Coarse-Grained Soils, with Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100%	‹50% of "Coarse Fraction"	12% to 50%		‹4 or ‹"A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					‹7 and ›"A" Line		
		SM	Silty sands, sand-silt mixtures.		›50% of "Coarse Fraction"			›4 or ‹"A" Line		
		SC	Clayey sands, sand-clay mixtures.					›7 and ›"A" Line		
IVA	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100%	100%	›50%	‹50	‹4 or ‹"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clay, lean clays.					›7 and ›"A" Line		
IVB (1)	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100%	100%	›50%	›50	‹"A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					›"A" Line		
V	Organic Soils (Unsuitable for backfill)	OL	Organic silts and organic silty clays of low plasticity.	100%	100%	›50%	‹50	‹4 or ‹"A" Line		
		OH	Organic Clays of Medium to high plasticity, organic silts.				›50	‹"A" Line		
	Highly Organic (Unsuitable for backfill)	PT	Peat and other high organic soils.							

(1) See Section 3010, 2.01 D 2 of this Developmental Specification for restrictive use.

F. Unsuitable Material: Remove unsuitable materials from the site including, but not limited to, the following:

1. Rock with gradation not meeting the stated gradation for stabilization material.

2. Individual stones or concrete chunks larger than 6 inches (150 mm), and averaging more than one per each cubic foot (0.03 m^3) of soil.

3. Frozen materials.

4. Stumps, logs, branches, and brush.

5. Trash, metal, or construction waste.

6. Soil in clumps or clods larger than 6 inches (150 mm), and without sufficient fine materials to fill voids during placement.

7. Unsuitable soils, as defined in Article 2102.06, A, 2 of the Standard Specifications, excluding material used as topsoil.

8. Class V Material (ASTM D 2321) as defined in Section 3010, 2.08 of this Developmental Specification.

9. Environmentally contaminated soil.

G. Replacement of Unsuitable Soils:

1. If the excavated material is determined by the Engineer to be unsuitable and cannot be conditioned so that it becomes suitable, furnish all necessary backfill material.

2. Remove and dispose of unsuitable material from the site.

2.02 STABILIZATION (FOUNDATION) MATERIALS

A. Clean 2 1/2 inch (63.5 mm) crushed stone or crushed P.C. concrete material, with the following gradation:

Sieve	Percent Passing
2 1/2 inch (63 mm)	100
2 inch (50 mm)	90 to 100
1 1/2 inch (37.5 mm)	35 to 70
1 inch (25 mm)	0 to 20
1/2 inch (12.5 mm)	0 to 5

B. The Engineer may authorize a change in gradation subject to materials available locally at time of construction. Subject to the Engineer's approval, crushed concrete may be used if it is within plus or minus 5% of the gradation for each size of material.

2.03 CLASS I GRANULAR BEDDING AND BACKFILL MATERIAL (SANITARY SEWERS)

A. Granular bedding shall be gravel, or crushed stone, complying with the following gradation:

Sieve	Percent Passing
1 1/2 inch (37.5 mm)	100
1 inch (25 mm)	95 to 100
1/2 inch (12.5 mm)	25 to 60
No. 4 (4.75 mm)	0 to 10
No. 8 (2.36 mm)	0 to 5

Note: The Engineer may authorize the use of crushed PCC for pipe sizes up to 12 inches (300 mm) or a change in gradation subject to materials available locally at time of construction.

B. Use aggregates having a percentage of wear, Grading A or B, not exceeding 50%, determined according to AASHTO T 96.

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

2.04 CLASS II BACKFILL MATERIAL (SANITARY SEWERS)

A. Class II material is manufactured and non-manufactured open graded (clean) or dense graded (clean) processed aggregate, clean sand, or coarse grained natural soils (clean) with little or no fines.

B. Class II material is non-plastic soil less than 1 1/2 inches (37.5 mm) in size and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 μm) sieve. Clean.	Where hydraulic gradient exists check gradation to minimize migration. Clean groups suitable for use as drainage blanket and underdrain.
GP	Poorly graded gravels and gravel sand mixtures, little or no fines. 50% or more retained on No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 μm) sieve. Clean.	
SW	Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 μm) sieve. Clean.	
SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 (4.75 mm) sieve. More than 95% retained on No. 200 (75 μm) sieve. Clean.	

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

D. Class II material may be specified in the contract documents by the Engineer between the pipe embedment zone and the top 2 feet (0.6 m) of final backfill when the trench is under the pavement.

2.05 CLASS III BACKFILL MATERIAL (SANITARY SEWER)

A. Class III material is natural coarse grained soils with fines.

B. Class III material follows Section 3010, 2.01 of this Developmental Specification and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GM	Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 μm) sieve.	Do not use where water condition in trench may cause instability.
GC	Clayey gravels, gravel-sand-clay mixtures. 50% or more retained on No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 μm) sieve.	
SM	Silty sands, sand-silt mixtures. More than 50% passes No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 μm) sieve.	
SC	Clayey sands, sand-clay mixtures. More than 50% passes No. 4 (4.75 mm) sieve. More than 50% retained on No. 200 (75 μm) sieve.	

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

2.06 CLASS IVA BACKFILL MATERIAL (SANITARY SEWER)

A. Class IVA material is natural fine grained inorganic soils.

B. Class IVA material follows Section 3010, 2.01 of this Developmental Specification and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
ML	Inorganic silts, very fine sands, rockflous, silty, or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 (75 μm) sieve.	Obtain geotechnical evaluation of proposed material. May not be suitable under deep fills, surface applied wheel loads, and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 (75 μm) sieve.	

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

D. Suitable only in dry trench conditions.

2.07 CLASS IVB BACKFILL MATERIAL (SANITARY SEWER)

A. Class IVB material is natural fine grained inorganic (high elastic silts and plastic clays - fat clay) with a liquid limit greater than 50%.

B. Class IVB material follows Section 3010, 2.01 of this Developmental Specification and consist of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 (75 μm) sieve.	Not to be used in pipe embedment zone.
CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 (75 μm) sieve.	

C. Compaction: See Section 3010, 3.06 of this Developmental Specification.

D. Upon the approval of the Engineer Class IVB materials may be used as final backfill in a dry trench.

E. Do not use Class IVB materials in the pipe embedment zone.

2.08 CLASS V BACKFILL MATERIAL (UNSUITABLE BACKFILL)

A. Class V Material is natural highly organic soils with a liquid limit of greater than 50%. See Section 3010, 2.01 of this Developmental Specification.

B. Use Class V Material only as topsoil outside of the pavement, unless otherwise specified by the Engineer.

C. Do not use Class V Material in the pipe embedment zone.

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2.11 SPECIAL PIPE EMBEDMENT MATERIAL

A. Concrete Supports: Where specified in the contract documents, construct concrete support systems in accordance with Figures 3010.2, 3010.3, 3010.4, 3010.5, 3010.6, and 3010.7 on the plans.

B. Concrete Bedding, Arch, or Encasement:

1. Concrete: commercial, 4,000 psi (27.6 MPa) compressive strength.

2. Unreinforced, unless otherwise shown in the plans.

3. Minimum concrete thickness: 6 inches (150 mm) or as shown on the plans.

C. Flowable Mortar:

1. Approximate quantities per cubic yard (cubic meter):

a. Cement 100 pounds (60 kg)
b. Fly ash 300 pounds (180 kg)

c. Fine aggregate 2,600 pounds (1,545 kg)
d. Water, approximate 70 gallons (345 L)

2. Compressive strength at 28 days: 100 psi to 200 psi (690 kPa to 1,380 kPa).

D. Controlled Low Strength Material (CLSM):

1. Approximate quantities per cubic yard (cubic meter):

a. Cement 50 pounds (30 kg)
b. Fly ash 250 pounds (150 kg)
c. Fine aggregate 2910 pounds (1,729 kg)
d. Water, approximate 60 gallons (296 L)

2. Compressive strength at 28 days 50 psi (345 kPa).

2.12 CASING PIPE WITH CARRIER PIPE

See Sections 3020 2.01, 2.02, 2.03, and 2.04 of this Developmental Specification.

PART 3 - EXECUTION

3.01 PREPARATION

A. When natural soils for Class II, III, and IV backfill material is required as specified in Figure 3010.1 on the plans, provide written certification from a testing laboratory that the material meets the class specified if so requested by the Engineer.

B. Locate, mark, and protect existing utilities and facilities in the work area.

C. Provide access to utility service locations, such as valves, utility accesses, and utility poles.

D. Identify owners of utilities on or near the site, and notify them of operations to occur.

E. Protect existing facilities and landscaping features, or replace as shown on the plans.

F. Protect bench marks, control points, and land survey monuments, or replace at Contractor's expense.

3.02 TRENCH EXCAVATION

A. Notify the Engineer prior to the start of excavation activities.

B. Remove and stockpile the top 8 inches (200 mm) of topsoil for subsequent reuse.

C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

D. Remove rock, rubbish, boulders, debris, and other unsuitable materials at least 6 inches (150 mm) below, and on each side of the pipe. Restore grade using soil suitable for backfill.

E. Correct unauthorized excavation at no cost to Contracting Authority, using bedding or stabilization materials.

F. Provide protective fences and barricades around open excavations, appropriate to the surrounding area.

G. Provide scale tickets for stabilization material to the Engineer at the time of delivery.

H. Provide safety fence around open excavations.

I. Trench Excavation for Sanitary Sewers:

1. Maximum and minimum pipe trench width: See Figure 3010.1 on the plans.

2. Flat trench bottom, conduit bearing directly on trench bottom (not applicable for rock excavation) for water main pipe only with bell hole shaping.

a. Shape trench bottom to support pipe around 1/4 of perimeter for the full length of the pipe barrel.
b. Provide bell holes.

3. Trench bottom, conduit supported by bedding material.

a. Excavate trench as shown in detailed drawings.
b. Install bedding material to support the full length of the pipe barrel.

4. Trench depth:

a. See Figure 3010.1 on the plans.
b. For those material types not shown in Figure 3010.1 on the plans, the maximum height of bury shall be 20 feet (6 m) without a designed trench with the Engineer's certification.

J. Structure Excavation:

1. For concrete structures and parts of structures without footings, 18 inches (450 mm) outside the horizontal projection of the structure.

2. For concrete structures with footings, 18 inches (450 mm) outside the footings.

3. For anchor rods, 12 inches (300 mm) on each side of the rod.

4. For buried anchors, the face of the buried anchor on one side and 24 inches (600 mm) outside the buried anchor on the other face.

3.03 ROCK OR UNSTABLE SOILS IN TRENCH BOTTOM

A. Notify the Engineer prior to over-excavation.

B. The Engineer will determine the need for trench bottom stabilization prior to installation of pipes and structures.

C. See Figure 3010.1 on the plans for over-excavation of rock and wet or soft foundations.

D. Provide scale tickets for the stabilization material to the Engineer at the time of delivery.

3.04 SHEETING, SHORING, AND BRACING

A. Ensure sheeting and bracing of all excavations conforms to the latest state and federal regulations governing safety of workers in the construction industry.

B. Leave in place all temporary sheeting below 2 feet (600 mm) over top of pipe unless sheeting removal plan is approved by the Engineer.

C. Move trench boxes carefully to avoid excavated wall displacement or damage.

D. When necessary or required, install adequate sheeting and bracing to prevent ground movement that may cause damage or settlement to adjacent structures, pipelines, and utilities.

E. Damage due to settlement because of failure to use sheeting or because of inadequate bracing, or through negligence or fault of the Contractor in any other manner, shall be repaired at the Contractor's expense.

F. Shore, sheet, brace, slope, or otherwise support by means of sufficient strength all sides of trenches in unsuitable, loose or soft material to protect employees working within them.

G. Where excavations are made with vertical sides that require supporting, use sufficiently strong sheeting and bracing to sustain the sides of the excavations and to prevent movement that could in any way injure the work, or adjacent structures, or diminish the working space sufficiently to delay the work.

H. Select sheeting and bracing material which: (1) is of sufficient dimensions and strength to adequately support the sides of trenches and excavations; (2) does not split when driving; and (3) is free of imperfections that may impair its strength or durability.

I. Drive sheeting to true alignment. Ensure contact of adjacent pieces.

J. In wet excavation use grooved sheeting to prevent passage of soil. Fill all voids between sheeting and face of excavation with suitable material.

K. Do not remove sheeting and bracing before the completion of the work, unless otherwise directed by the Engineer.

L. For sheeting that is left in place, cut off 18 inches (0.5 m) for clearance below the bottom of the pavement in streets/highways and 18 inches (0.5 m) below the original ground surface, unless otherwise required by the contract documents or the Engineer. Leave in place all temporary sheeting below 2 feet (0.6 m) over top of pipe unless sheeting removal plan is reviewed by the Engineer.

3.05 DEWATERING

A. Do all work in dry conditions; do not install pipes on excessively wet soil.

B. Submit a dewatering plan to the Engineer. Perform the dewatering operation according to the dewatering plan. Dewatering operations may be modified from the plan for actual field conditions, with approval of the Engineer.

C. Adequate dewatering is the Contractor's responsibility unless otherwise stated in the contract documents.

D. Install a dewatering system appropriate for the soil conditions.

E. Maintain water levels sufficiently below the bottom of trench excavation (typically 2 feet (0.6 m)) to prevent upward seepage.

F. Provide for handling water encountered during construction:

1. Prevent surface water from flowing into excavation. Remove water as it accumulates.

2. Do not use sanitary sewers for disposal of trench water. Discharging water into storm sewers requires the Engineer's approval.

3. Do not discharge water onto adjacent property without property owner's written approval.

4. Maintain and control water discharge as necessary so not to create a safety hazard for vehicular and pedestrian traffic.

5. Direct water discharge away from electrical facilities or equipment, and intersections.

6. Use noise and fume reduction equipment to minimize disturbance.

7. Provide at least two operating pumps for each trench opened in wet ground and at the same time have one pump in reserve.

G. Place backfill in trenches prior to stopping dewatering operations.

H. Protect trench water discharge points from erosion.

I. Operate dewatering systems to prevent damage to adjoining structures and facilities.

J. Monitor adjoining structures and facilities during dewatering operations. Cease dewatering operations and notify the Engineer if damage is observed.

3.06 PIPE INSTALLATION

Refer to Figures 3010.1 to 3010.9, included on the plans, as appropriate for the installation being made. Use only the types of materials shown for each position within the trench, for the given groundwater conditions, for the compaction to be provided, and for the type of pipe being installed.

A. Pipe Bedding:

1. Shape pipe bed to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe.

2. Install pipe and system components.

3. Place bedding simultaneously on both sides of the pipe. Correct any pipe displacements before proceeding.

4. Place bedding in lifts not greater than 6 inches (150 mm) thick and consolidate.

5. Concrete encasement: Install where shown on the plans.

6. If required in the contract documents, or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other bedding material types.

7. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

B. Haunch Support:

1. Place granular haunch material in lifts not greater than 6 inches (150 mm) thick and

consolidate by slicing with a shovel or using other approved techniques.

2. If required in the contract documents or approved by the Engineer, concrete, flowable mortar, or controlled low strength material may be used instead of other haunch material types. Secure pipe against displacement or flotation prior to placing flowable mortar, controlled low strength material, or concrete encasement.

C. Primary and Secondary Backfill (Pipe Cover):

1. Place pipe cover material in 6 inches (150 mm) lifts and compact to densities required according to class of material. See Figure 3010.1 (sheet 1) on the plans.

2. If required in the contract documents, or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other cover material types.

3. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

4. Special Pipe Support: If required, provide special pipe support as shown on the plans (see Figures 3010.4 to 3010.6 on the plans).

D. Final Trench Backfill:

1. Place backfill in the trench immediately after recording locations of connections and appurtenances, or at the Engineer's direction.

2. Place backfill adjacent to structures immediately after concrete has reached design strength and connecting work has been completed.

3. Allow no more than 100 feet (30 m) of trench to be open overnight or when work is not in progress except as provided on the plans.

4. Place suitable excavated backfill:

- **a.** Carefully place backfill over top of pipe and around structures.
- **b.** Compact as required.

5. Compaction:

- **a.** Within street right-of-way, compact each lift to at least 95% of maximum Standard Proctor Density; otherwise, compact to at least 90%.
- **b.** In areas more than 3 feet (900 mm) below pavement structure, place backfill in lifts no thicker than 8 inches (200 mm).
- **c.** In areas less than 3 feet (900) feet below pavement structure, place backfill in lifts no thicker than 6 inches (150 mm). Terminate backfill at 8 inches (200 mm) below finish grade in areas to remain unpaved, and to subgrade elevation in areas to be paved. Place 8 inches (200 mm) of topsoil in unpaved areas.

- **d.** For Vitrified Clay Pipe (VCP), keep all heavy compaction equipment 5 vertical feet (1.5 vertical meters) above the top of the pipe. In the area less than 5 vertical feet (1.5 vertical meters), use hand held compactors. Do not allow the compactor to come in contact with the pipe.

6. Moisture Range: Obtain required compaction within a soil moisture range of optimum moisture to 4% above optimum moisture content.

7. Dispose of surplus and unsuitable materials.

8. Hydraulic compaction (flooding with water) is not allowed unless authorized by the Engineer.

E. Casing Pipe: Place bedding and backfill materials for casing pipes the same as for a rigid gravity flow pipe.

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3.08 STRUCTURE BEDDING

A. Bedding for Structures Bearing on Undisturbed Soils:

1. Shape the bottom to accurate grade and size.

2. Remove loose material, large clods, stones, and foreign materials.

3. In unstable soils or rock conditions see Section 3010, 3.03 of this Developmental Specification for stabilization requirements.

B. Bedding for Structures Bearing on Bedding Material:

1. Over excavate to minimum of 8 inches (200 mm) or as specified in the contract documents.

2. Place bedding material for structures in accordance with the contract documents and with the material and control specified in Figure 3010.1 on the plans.

3.09 STRUCTURE BACKFILL

A. Removal of Forms and Falsework:

1. Remove forms for utility accesses and intake walls and tops according to Article 2403.18 of the Standard Specifications.

a. References to culverts include all sanitary and storm structures.
b. When allowed by the Engineer, compressive strengths as six times the stated flexural strengths may be used in determining concrete strength of structure roofs.

2. Chip out and repair honeycomb areas per the direction of the Engineer.
3. Break back form ties and fill holes with Portland cement mortar.
4. Remove flashing and thin webs.

B. Backfill Placement: Place backfill after structure concrete has reached at least 80% of the design strength and connecting work has been completed, unless otherwise specified. Determine strengths under comparable conditions. If strength is not determined, place backfill after 14 days.

C. Backfill Against Walls and Around Structures:

1. Where backfill is required on both sides of a concrete wall and around sides of monolithic structures, proceed with filling operations simultaneously on all sides of walls and structures so the fill is kept at approximately the same elevation at all times. Consider concrete box, arch, and circular culverts to be monolithic structures.

2. Compact the 3 feet (900 mm) closest to all walls or wing faces using pneumatic or hand tampers only.

D. Backfilling with Excavated Material:

Unless otherwise specified, see Section 3010, 3.06 D of this Developmental Specification for suitable excavated materials for backfill.

3.10 OPEN CUT CASING PIPE INSTALLATION

A. Casing Pipe: Install according to Section 3010, 3.01 to 3.07 of this Developmental Specification, as appropriate.

B. Carrier Pipe: Install according to Section 3020, 3.05 of this Developmental Specification.

3.11 FIELD QUALITY CONTROL

A. References:

1. ASTM C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

2. ASTM D 698, Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Moisture Using 5.5 Pound (4.54 kg) Rammer and 12 inch (305 mm) Drop. (Standard Proctor Method)

3. ASTM D 1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

4. ASTM 2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

5. ASTM D 2922 and D 3017, Test Methods for Density of Soil and Soil-Aggregate in Place and Water Content of Soil and Rock by Nuclear Methods (Shallow Depth).

6. ASTM D 4253 and D 4254, Test Methods for Maximum Index Density of Soils using a Vibratory Table and Minimum Index Density of Soils and Calculation of Relative Density.

B. Compaction Testing: Provide compaction testing of backfill, using the services of an independent testing laboratory approved by the Engineer, unless testing is provided by the Engineer.

C. Schedule Testing: Notify the Engineer when work is prepared for testing.

D. Soil Testing:

1. Cohesive soils: Determine moisture-density relationships by ASTM D 698 (Standard Proctor). Perform at least one test for each type of cohesive soil used.

2. Cohesive soils: Determine in-place density and moisture content using ASTM D 1556 (sand-cone method) and D 2216 or ASTM D 2922 and D 3017 (nuclear).

3. Non-cohesive soils: Determine maximum and minimum index density and calculate relative density using ASTM D 4253 and D 4254 (cohesionless soils).

4. Gradation: Test in accordance with ASTM C 136.

E. Testing Frequency and Locations: Perform testing of the final trench backfill, beginning at a depth of 2 feet (600 mm) above the top of the pipe, as follows:

1. Contractor Provided:

    a. Make one test per each 2 vertical feet (600 vertical mm) of consolidated fill at each street crossing.
    b. Make one test per each 2 vertical feet (600 vertical mm) of consolidated fill for each 200 horizontal feet (60 horizontal m) of trench.
    c. Additional testing may be required by the Engineer if non-compliance or a change in conditions occurs.
    d. Coordinate the timing of testing with the Engineer.
    e. The Engineer will determine the location of testing.
    f. If necessary, excavate to the depth and size as required by the Engineer to allow compaction tests. Place backfill and recompact.

2. Contracting Authority Provided:
    a. Coordinate the timing of testing with the Engineer.
    b. The Engineer will determine the location of testing.
    c. Test frequency will not exceed one test per each 2 vertical feet (600 vertical mm) of consolidated fill for each 200 horizontal feet (60 horizontal m) of trench.

F. Test Failure: Rework, recompact, and retest as necessary until specific compaction is achieved in all areas of the trench.

G. Retesting: In event of failed tests, the Engineer may require retest as deemed necessary, at no additional cost to the Contracting Authority.

SECTION 3020 - TRENCHLESS CONSTRUCTION (BORING, JACKING, AND TUNNELING)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Trenchless installation of carrier pipe with casing pipe.

B. Trenchless installation of carrier pipe without casing pipe.

1.02 DESCRIPTION OF WORK

A. Excavate launch and receiving pits.

B. Install casing pipe (if required).

C. Install carrier pipe.

D. Backfill excavations.

E. Possible methods of trenchless installation (refer to Section 3020, 3.05 of this Developmental Specification for restrictions):

1. Auger Boring: A boring method that utilizes a rotating cutting head to form the bore and a series of rotating augers inside a casing pipe to remove the spoil.

2. Compaction Method: Boring methods that displace soil radially rather than removing spoil. Bore hole may be formed with a push rod or impact mole.

3. Directional Drilling: A boring method for installing pipe from a surface launched drilling rig. A pilot bore is formed and then enlarged by back reaming. The product pipe is then pulled in.

4. Pipe Ramming: A boring method that involves driving a steel casing pipe with a percussive hammer. The front end of the casing pipe may be open ended or closed. If open, spoil must be removed from the pipe.

5. Slurry Boring: A boring method that first forms a pilot bore by forcing a drill tube through the ground. The pilot hole is then enlarged by reaming. As the hole is enlarged with the reamer, drilling fluid (slurry) is pumped into the hole to hold the soil cuttings in suspension. After reaming, the product pipe is pulled into place.

6. Microtunneling: A boring method that consists of a remotely controlled pipe jacking operation utilizing a tunnel boring machine. Personnel entry is not required.

7. Pipe Jacking: A jacking method in which pipe is pushed into the ground with hydraulic rams while soil is simultaneously excavated. Excavation is normally completed with a tunnel boring machine. This method requires personnel to enter the tunnel during the excavation process.

8. Utility Tunneling: A method of forming large diameter tunnels. As excavation takes place at the front of the tunnel, a liner is constructed to temporarily support the tunnel. Upon completion of the tunnel, the product pipe is pushed in place.

9. Other proven methods not described here may be allowed upon approval of the Engineer.

1.03 SUBMITTALS

A. Proposed installation methods and equipment.

B. Samples, granular bedding material: submit 10 pound (5 kg) samples, if required.

C. Samples, granular backfill material: submit 10 pound (5 kg) samples, if required.

D. Gradation reports for fill materials and bedding materials unless the material used has been submitted and approved for related work on the project.

E. Results of Standard Proctor and In-Place Density Tests on pit backfill if required.

F. Construction sequence.

G. Catalog cuts, samples, and manufacturer's data and listing of applicable standards for special, unique, or proposed substitute materials if requested by the Engineer.

H. Certification that materials being provided meet the requirements of this Developmental Specification or that alternate materials or substitutions have received written approval of the Engineer. Include shop drawings of casing spacers and proposed spacing.

I. Project Record Documents.

J. Provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

Obtain approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.

B. Remove unsuitable and excess materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on the plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

B. Use of Explosives: Submit detailed plans outlining all proposed blasting operations, locations, methods, and use of mats and other safety measures to the Engineer.

1. Obtain written approval before using explosives.

2. Use personnel experienced with explosives.

1.08 MEASUREMENT FOR PAYMENT

A. Boring, Jacking, or Tunneling with Casing Pipe: The length of casing pipe and carrier pipe properly installed will be measured along the centerline of the casing. Payment will be made for both the carrier pipe and casing pipe as a combined single contract unit for the appropriate method of installation.

B. Jacking or Boring without a Casing Pipe: The length of the carrier pipe properly installed will be measured along the centerline of the carrier pipe.

C. Incidental Items: Unless otherwise specified in the contract documents the following items shall be included in the contract unit price for boring, jacking, or tunneling:

1. Launch or reception pits, or other construction excavations.

2. Placement, compaction, and testing of backfill material in excavations and pits.

3. Casing Spacers, annular space fillers, levels, backfill, casing and seals, and other appurtenances necessary to perform specified function.

PART 2 - PRODUCTS

2.01 CARRIER PIPE

See Section 4010, 2.01 of this Developmental Specification, or refer to the contract documents.

2.02 CASING PIPE

A. Casing Pipe: Use only new, welded, or seamless steel pipe per ASTM A139, Grade B; ASTM A252, Grade 2; or ASTM A53, Grade B.

B. Joints:

1. Comply with American Welding Society Code of Arc and Gas Welding in Building Construction. Fully weld all joints with full penetrating weld.

2. Upon approval of the Engineer, an interlocking casing pipe connection system may be used instead of field welding the sections of casing pipe.

C. Casing Pipe Diameter: Minimum inside diameter as shown on the plans. If not shown, use a minimum casing diameter of at least 4 inches (100 mm) greater than the largest outside diameter of the carrier pipe, including pipe bells.

D. Steel Casing Pipe Minimum Wall Thickness:

NOMINAL DIAMETER INCHES (mm)	WALL THICKNESS, MINIMUM INCHES (mm)	
	UNDER HIGHWAY	UNDER RAILROAD
6 thru 14 (150 thru 355)	0.188 (4.78)	0.25000 (6.35)
16 (465)	0.188 (4.78)	0.28125 (7.14)
18 (450)	0.25 (6.35)	0.31250 (7.94)
20 (510)	0.25 (6.35)	0.34375 (8.73)
22 (560)	0.25 (6.35)	0.34375 (8.73)
24 (600)	0.281 (7.14)	0.37500 (9.53)
26 (660)	0.281 (7.14)	0.40625 (10.32)
28 (710)	0.312 (7.92)	0.43750 (11.11)
30 (750)	0.312 (7.92)	0.46875 (11.91)
32 (815)	0.312 (7.92)	0.50000 (12.70)
34 (865)	0.312 (7.92)	0.53125 (13.49)
36 (900)	0.344 (8.74)	0.53125 (13.49)
38 (965)	0.344 (8.74)	0.56250 (14.29)
40 (1015)	0.344 (8.74)	0.59375 (15.08)
42 (1050)	0.344 (8.74)	0.62500 (15.88)
44 (1120)	0.344 (8.74)	0.65625 (16.67)
46 (1170)	0.344 (8.74)	0.65625 (16.67)
48 (1200)	0.344 (8.74)	0.68750 (17.46)
50 (1270)	Sizes greater than 48 inches (1200 mm) diameter will be as specified in the contract documents	0.71875 (18.26)
52 (1320)		0.75000 (19.05)
54 (1370)		0.78125 (19.84)
56 (1420)		0.81250 (20.64)
58 (1470)		0.81250 (20.64)
60 (1525)		0.84375 (21.43)
62 (1575)		0.87500 (22.23)
64 (1625)		0.90625 (23.02)
66 (1675)		0.93750 (23.81)
68 (1725)		0.93750 (23.81)
70 (1780)		0.96875 (24.61)
72 (1830)		1.00000 (25.40)

2.03 CASING SPACERS

A. Use manufactured casing spacers to position carrier pipe in casing. Wood skids will not be allowed.

B. Use the following material requirements for casing spacers:

1. HDPE Band/Panel and Riser: ASTM D 638.
2. Stainless Steel or Carbon Steel Band/Panel and Riser: Type 304 stainless steel per ASTM A 240 or carbon steel per ASTM 36.

a. **Liner:** Elastomeric PVC per ASTM D 149.
b. **Spacer Skid/Runner:** Abrasion resistant polymer with a low coefficient of friction.
c. **Fasteners:** Type 304 (18-8) stainless steel per ASTM A 193.

2.04 BACKFILL FOR ABANDONED TUNNELS

A. Option 1 - PCC, 3,000 psi (20.7 MPa) minimum, approximately 4 inch (100 mm) slump.

B. Option 2 - Flowable mortar or controlled low strength material (CLSM) per Section 3010, 2.11 of this Developmental Specification.

2.05 CASING END SEAL

A. Manufactured synthetic rubber casing end seal with a minimum 1/8 inch (3 mm) thickness and stainless steel bands and fasteners.

B. PCC meeting the requirements of Article 2403 of the Standard Specifications. Do not use PCC casing end seals with flexible pipes.

PART 3 - EXECUTION

3.01 PREPARATION

A. Verify suitability of excavated materials for reuse as backfill.

B. Locate, mark, and protect existing utilities and facilities in the work area.

C. Provide access to utility service locations, such as valves, utility accesses, and utility poles.

D. Identify owners of utilities on or near the site, and notify them of operations to occur.

E. Protect existing facilities and landscaping features or replace as shown on the plans.

F. Protect bench marks, control points, and land survey monuments or replace at Contractor's expense.

G. Select a method of installation that: (1) is appropriate for the soil conditions anticipated; (2) allows the pipe to be installed to the desired line and grade within the specified tolerances; and (3) prevents heaving or settlement of the ground surface or damage to nearby facilities.

3.02 EXCAVATION

A. Notify the Engineer prior to the start of tunneling activities.

B. Remove and stockpile the top 8 inches (200 mm) of topsoil for subsequent reuse. Do not mix topsoil with other excavated materials.

C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

D. Remove rock, rubbish, debris, and unsuitable materials.

E. Excavate the minimum size pits necessary to safely and properly perform the work.

3.03 SHEETING, SHORING, AND BRACING (See Section 3010, 3.04 of this Developmental Specification)

Provide and install sheeting, shoring, and bracing or trench boxes as required to safely perform work, protect nearby structures, and work under construction.

3.04 DEWATERING

See Section 3010, 3.05 of this Developmental Specification.

3.05 TRENCHLESS INSTALLATION

A. General:

1. Install pipes by boring, jacking, or tunneling only where required by the plans.

2. Place bedding and backfill of the carrier pipe beyond the end of the casing pipe, in tunneling pits, and in casing pipes installed by open-cut trenching according to Section 3010 of this Developmental Specification.

3. Install pipe at line and grade. Comply with the following:

a. Line and grade permit the carrier pipe to be installed at its true starting elevation and grade within a maximum alignment deviation of the pipe centerline as specified in the contract documents.

b. When no deviation tolerances are specified in the contract documents, the following maximums apply:

1) Gravity Pipe:
Horizontally: ±1.0 foot per 100 feet (±300 mm per 30 m);
Vertically: ±0.2 foot up to 100 feet (±60 mm up to 30 m); an additional ±0.1 foot (±30 mm) per 100 feet (30 m) thereafter. Do not allow backfill in the pipe.

2) Pressurized Pipe:
Horizontally: ±2.0 foot (±600 mm)
Vertically: ±1.0 foot (±300 mm). Maintain minimum depth specified by the local jurisdiction.

c. Greater deviation or interference with other identified facilities may be cause for rejection.

4. Provide additional fittings, utility accesses, or appurtenances needed to accommodate any horizontal or vertical misalignment, if allowed by the Engineer, at no additional cost to the Contracting Authority.

5. Contractor will be allowed to correct errors in grade of the casing pipe in order to achieve design grade of the carrier pipe by pouring an invert in the casing pipe, or by shimming the carrier pipe to a uniform grade, provided adequate clearance remains for proper installation of the carrier pipe.

6. Rejected tunnels shall be replaced at the Contractor's expense. This includes additional fittings, utility access, or appurtenances needed to replace the rejected work.

B. Casing Pipe or Un-cased Carrier Pipe Installation:

1. Install pipe by auger boring, pipe jacking, microtunneling, open-ended pipe ramming, directional drilling (back-reaming required), or utility tunneling.

2. Do not use methods that displace excess soil, rather than removing it, such as impact moling, push rod, or closed end pipe ramming unless specified in the contract documents, or

permitted by the Engineer.

3. Water jetting will not be allowed.

4. Use a jacking collar, timbers, and other means as necessary to protect the driven end of the pipe from damage.

5. Fully support borehole at all times to prevent collapse. Insert pipe as earth is removed, or support bore with drilling fluid.

6. Fully weld all casing pipe joints or use an interlocking connection system according to Section 3020, 2.02 of this Developmental Specification.

7. Fill annular space between the inside of the bore hole and the outside of the pipe if the space is greater than 1 inch (25 mm). Use flowable mortar, CLSM (see Section 3010 of this Developmental Specification), or 3,000 psi (20.7 MPa) concrete.

C. Carrier Pipe Installation Through Casing:

1. Clean dirt and debris from the casing pipe after installation.

2. Install casing spacers to pipe sections as necessary to support pipe barrel according to the pipe manufacturer's recommendation.

- **a.** Space according to the pipe manufacturer's recommendation. As a minimum, place a spacer within 1 foot (900 mm) of each side of the joint and a maximum spacing of 6 feet (1.8 m).
- **b.** Do not allow pipe to be supported by joint bells.
- **c.** Lubricate casing spacers with drilling mud or flax soap. Do not use petroleum-based lubricants or oils.

3. Ensure that thrust loads will not damage carrier pipe joints. Provide thrust collars between joint shoulders of concrete pipe.

4. Provide timbers for sufficient cushioning between the end of the pipe pushed and the jacking equipment to prevent damage to the pipe. Do not allow steel jack face to thrust against unprotected pipe end.

5. Position jacks so the resulting force is applied along the centerline of the pipe, and the force is applied evenly to the entire end of the pipe.

6. Assemble pipe joints in the jacking pit, before pushing the carrier pipe into the casing.

7. Close end of casing pipe around the carrier pipe with a casing end seal. Do not use the PCC casing end seals with flexible pipe.

8. Fill the annular space between the carrier and casing pipe, only if required on the plans, with flowable mortar or CLSM per Section 3010, 2.11 of this Developmental Specification.

3.06 FIELD QUALITY CONTROL

Provide compaction testing of backfill material and embankment, if required, as part of the field quality control for the carrier pipe line being constructed. Ensure that at least one compaction test site occurs at each pit.

DIVISION 4 - SEWERS AND DRAINS

SECTION 4010 - SANITARY SEWERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Sanitary Sewers Gravity Mains.

B. Sanitary Sewer Force Mains.

C. Sanitary Sewer Services.

1.02 DESCRIPTION OF WORK

A. Construct sanitary sewer gravity and force mains.

B. Construct or relocate building sanitary sewer services, stubs, and connections.

1.03 SUBMITTALS

A. Manufacturer′s instructions for installation of pipe and appurtenances.

B. Construction sequence.

C. Catalog cuts, samples, and manufacturer′s data and listing of applicable standards for special, unique, or proposed substitute materials if requested by the Engineer.

D. Certification that materials being provided meet the requirements of this Developmental Specification or that alternate materials or substitutions have received written approval of the Engineer.

E. Project Record Documents.

F. Provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

Obtain written approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

Store materials and handle to avoid damage. Replace damaged materials. Remove damaged materials from site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose potential conflicts such as utility lines and drainage structures in advance of

construction. Verify elevations and locations, and verify clearance for proposed construction.

2. Complete elements of work that can affect line and grade in advance of sanitary sewer construction unless noted on plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

1.08 MEASUREMENT FOR PAYMENT

A. Sanitary Sewer Gravity Mains:

1. Measurement of pipe will be in linear feet (meters) along centerline of pipe in place.

2. Measurement of each size and type of pipe installed will be from center of utility access to center of utility access.

3. Payment will be made at the contract unit price for each size and type installed.

4. For sewer pipe installed within casing pipe (see Section 3020, 1.08 of this Developmental Specification), measurement of the length of casing/carrier pipe, properly installed, will be along the centerline of the casing. Payment will be made for both carrier and casing pipe as a single contract unit for the appropriate method of installation.

5. Wyes installed with mains will be considered incidental to the mains.

B. Sanitary Sewer Force Main:

1. Measurement of pipe will be in linear feet (meters) along centerline of pipe in place.

2. Measurement of each size and type of pipe installed will be from outside wall of pumping station to center of utility access, or from center of utility access to center of utility access.

3. Payment will be made at the contract unit price for each size and type installed.

4. For sewer pipe installed within casing pipe (see Section 3020, 1.08 of this Developmental Specification), measurement of the length of casing/carrier pipe, properly installed, will be along the centerline of the casing. Payment will be made for both carrier and casing pipe as a single contract unit for the appropriate method of installation.

C. Sanitary Sewer Services: The portion of the sanitary sewer service from the main to a point 10 feet (3 m) outside of the right-of-way line or as shown on the plans (see Figures 4010.1A and 4010.1B on the plans).

1. Measurement of pipe in linear feet (meters) will be along centerline of pipe in place.

2. Measurement of each size and type of pipe installed will be from end of pipe to centerline of sanitary sewer.

3. Payment will be made at the contract unit price for each size and type installed.

4. Tap and fittings will be considered incidental including required testing.

D. Sewer Service Relocation: The portion of an existing sanitary sewer service in a zone of conflict, as shown on Figure 4010.4 on the plans.

1. Completed relocation will be counted as a unit and shall include all work, materials, excavation, backfill, and compaction.

2. Payment will be made at the contract unit price for relocating sanitary sewer services for the actual number of sewer services relocated.

E. Intentionally Left Blank

F. Sewage Air Release Valve and Pit:

1. Each completed installation, including valve, accessories, and pit will be counted.

2. Payment will be made at the contract unit price for each sewage air release valve and pit installed.

PART 2 - PRODUCTS

2.01 SANITARY SEWERS (GRAVITY)

A. Solid Wall Polyvinyl Chloride Pipe (PVC) 8 inch to 15 inch (200 mm to 375 mm):

1. Conform to ASTM D 3034, pipe stiffness per ASTM D 2412, minimum thickness solid wall pipe SDR 23.5 (153 psi (1055 kPa)), 26 (115 psi (795 kPa)), 35 (46 psi (320 kPa)).

2. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.

3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.

B. Solid Wall Polyvinyl Chloride Pipe (PVC) 18 inch to 27 inch (450 mm to 675 mm):

1. Conform to ASTM F 679 (SDR 35 or equivalent) with T-1 minimum wall thickness, minimum pipe stiffness; 46 psi (320 kPa) as per ASTM D 2412.

2. PVC plastic meeting ASTM D 1784, Cell Classification ASTM 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.

3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.

C. Corrugated Polyvinyl Chloride Pipe (PVC) 8 inch to 36 inch (200 mm to 900 mm):

1. Conform to ASTM F 949, 46 psi (320 kPa) stiffness, smooth interior, corrugated exterior.

2. PVC resin meeting ASTM D 1784, Cell Classification ASTM 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.

3. Integral bell and spigot rubber gasket joint conforming to ASTM D 3212 and ASTM F 477. Double wide gaskets required (index into two valleys).

D. Closed Profile Polyvinyl Chloride Pipe (PVC) 21 inch to 36 inch (525 mm to 960 mm):

1. Conform to ASTM F 1803 (Closed Profile), minimum pipe stiffness 46 psi (320 kPa).

2. PVC plastic meeting ASTM D 1784, Cell Classification ASTM 12364. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.

3. Integral bell and spigot with elastomeric seals conforming to ASTM D 3212 and ASTM F 477.

E. Polyvinyl Chloride Composite Pipe (PVC Truss) 8 inch to 15 inch (200 mm to 375 mm):

1. Composite pipe constructed with truss type structure between inner and outer PVC walls with voids filled with lightweight concrete.

2. Conform to ASTM D 2680, minimum pipe stiffness, 200 psi (1380 kPa).

3. PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight (mass) per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, colorants, etc.

4. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and F 477.

F. Reinforced Concrete Pipe (RCP) 18 inch to 144 inch (450 m to 3650 mm):

1. Conform to ASTM C 76.

2. Minimum Class IV, Wall B.

3. Tongue and groove joints.

4. Rubber O-ring flexible joint conforming to ASTM C 443.

5. Coat interior pipe barrel and entire joint surfaces with two-component coal-tar epoxy-polyamide black paint or approved equal.

6. Lining Material: Steel Structures Painting Council (SSPC) Specification No. 16, Table 1.

- **a.** Minimum epoxy resin content 34% to 35% by dry film weight.
- **b.** Minimum sag resistance 40 mils (1 mm).
- **c.** Minimum solids 80% by volume.

7. Cure pipe, sand blast and thoroughly clean surfaces, and remove all loose materials.

8. Apply lining by airless spray to pipe barrel in multiple coats.

- **a.** Prime with thinned coating.
- **b.** Apply top coats.
- **c.** Provide recommended curing time between coats.
- **d.** Dry film thickness: Not less than 25 mils (635 µm) or more than 30 mils (760 µm).

9. Apply lining by brushing all joint surfaces.

a. Prime with thinned coating.
b. Apply top coat or coats.
c. Provide recommended curing time between coats.
d. Minimum dry film thickness: 8 mils (200 µm).

10. Cure pipe lining according to manufacturer′s recommendations, 5 days minimum.

G. Ductile Iron Pipe (DIP) 8 inch to 54 inch (200 mm to 1350 mm):

1. Conform to AWWA C 151/ANSI A 21.51.

2. Minimum pressure class: Class 52.

3. Interior linings.

a. Provide interior lining for ductile iron pipe and fittings used for all gravity sewers and drop connections.
b. Use linings specifically designed for sanitary sewer applications, which may include calcium aluminate, polyethylene, ceramic epoxy, and coal tar epoxy. Other lining types may be allowed upon approval of the Engineer.
c. Apply lining to interior of unlined ductile iron pipe and fittings according to the published specifications from manufacturer.
d. Seal all cut ends and repair field damaged areas according to the manufacturer's recommendations.

4. Exterior coating: asphalt.

5. Push on joint: AWWA C111/ANSI A 21.11.

6. Fittings: Mechanical joint AWWA C 110/ANSI A 21.10.

7. Polyethylene encasement:

a. Conform to AWWA C 105/ANSI A 21.5.
b. Minimum thickness: 8 mils (200 µm).
c. Use for all ductile iron pipe and fittings in buried service.

H. Vitrified Clay Pipe (VCP) 8 inch to 42 inch (200 mm to 1050 mm):

1. Use pipe and fittings conforming to ASTM C 700.

2. Use compression joints conforming to ASTM C 425 for plain end pipe (PEP) or bell and spigot pipe.

3. Test according to ASTM C 301

2.02 SANITARY SEWER FORCE MAIN

A. Ductile Iron Pipe (DIP) 4 inch to 54 inch (100 mm to 1350mm): See Section 4010, 2.01 of this Developmental Specification. If joint restraints are specified, see Section 5010, 2.03 of this Developmental Specification.

B. Polyvinyl Chloride Pipe (PVC):

1. Conform to AWWA C 900 for 4 inch to 12 inch (100 mm to 300 mm) pipe sizes. Conform to AWWA C 905 for 16 inch to 30 inch (400 mm to 750 mm) pipe sizes.

2. Minimum DR 18.

3. Integral bell and spigot joint with elastomeric gasket.

C. Sewage Air Release Valve:

1. Consists of an elongated tapered or conical body with outward-slanting walls and a float to operate (open and close) under pressure without spillage. Use a float with a flexible connection to the seal plug assembly to prevent irregular air release and protect the connecting rod. The bottom of the valve shall be sloped or funnel-shaped to encourage the accumulated sewage and solids to drain from the valve. Preserve a volume of air at all times between the liquid sewage and the seal plug assembly.

2. Materials:

- **a.** Body and cover: Stainless steel, fiberglass-reinforced nylon, or other corrosion-resistant materials
- **b.** Internal Linkage, Stem: Stainless Steel
- **c.** Float: Stainless Steel, ASTM A 240, ASTM T 304, or foamed polypropylene
- **d.** Seal Plug Assembly: Stainless steel, foamed polypropylene, EPDM rubber, reinforced nylon

3. Tapping saddle: Stainless steel or nylon

4. Pit: See Figure 4010.3 on the plans.

2.03 SANITARY SEWER SERVICE

A. Connection to Main

1. Polyvinyl Chloride (PVC) Main:

- **a.** Preformed wye or tee service fitting with gasket joints conforming to ASTM D 3034 or ASTM F 949.
- **b.** Preformed saddle wye or saddle tee for service tap conforming to ASTM D 3034 or ASTM F 949.
- **c.** PVC plastic meeting ASTM D 1784, Cell Classification 12454.

2. Polyvinyl Chloride (PVC) Truss Main:

- **a.** Preformed wye or tee service fitting with gasket joints conforming to ASTM D 3212 or on solvent weld per ASTM D 2680.
- **b.** Preformed saddle wye or saddle tee for service tap conforming to ASTM D 2680.

3. Reinforced Concrete Pipe (RCP) Main: Preformed saddle wye or saddle tee service tap designed for use with RCP.

4. Vitrified Clay Pipe (VCP) Main:

a. Precast VCP wye or tee service fitting conforming to ASTM C 700 for pipe and C 425 for compression joints.
b. Preformed saddle wye or saddle tee service tap designed for use with VCP.

5. Ductile Iron Pipe (DIP) Main:

a. Use DIP wye or tee fittings conforming to AWWA C 110 or C 153.
b. Preformed saddle wye or tee services tap designed for use with DIP. Saw cut the hole for the tap with equipment designed for that application.

B. Wye and Tee Pipe Stop: All saddle wye or saddle tee fittings must provide an integrally molded pipe stop in the branch for positive protection against service pipe insertion beyond the inside of sewer main pipe wall.

C. Service Pipe: Products as required by local plumbing code or regulations, if applicable. Otherwise use the following:

1. PVC:

a. Conform to ASTM D 3034, minimum thickness SDR 23.5; minimum pipe stiffness of 153 psi (1055 kPa) as per ASTM D 2412.
b. PVC plastic meeting ASTM D 1784, Cell Classification 12454.
c. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212.

2. DIP:

a. As specified for sanitary sewer force main.
b. Polyethylene encasement as specified.

D. Connection to Existing Service: See Section 4030, 2.08 of this Developmental Specification.

2.04 SANITARY SEWER SERVICE RELOCATIONS

A. Apply all requirements of Section 4010, 2.03 of this Developmental Specification to materials used for sanitary service relocation.

B. For new pipe, use the same size as the existing service being relocated.

C. If existing material does not comply with Section 4010, 2.03 of this Developmental Specification, replace it with material meeting the requirements of Section 4010, 2.03 of this Developmental Specification.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify measurements at site; make necessary field measurements to accurately determine pipe makeup lengths or closures.

B. Examine site conditions to ensure construction operations do not pose hazards to adjacent structures or facilities.

3.02 LINE AND GRADE

A. Install pipe to line and grade shown on plans. Set field grades to invert of pipes.

B. Notify the Engineer immediately if discrepancies or irregularities are discovered in line or grade shown by grade stakes.

C. Make detailed measurements as required to construct work to line and grade established by line and grade hubs.

D. Batter Boards: If approved by the Engineer, use batter boards on short pipe installations of 50 feet (15 m) or less.

E. Laser Beam: Use laser to guide line and grade.

1. Set laser equipment to proper line and grade from line and grade hubs.

2. Check line and grade of laser at 25 feet (7.5 m), 50 feet (15 m), 100 feet (30 m), and then at 100 foot (30 m) intervals thereafter for each setup.

3. Check line and grade of each pipe length.

3.03 PIPE INSTALLATION

A. Provide trench excavation, pipe bedding, and backfill as specified in Section 3010 of this Developmental Specification.

B. Install water tight plug to prevent water from entering the existing sewer system.

C. Begin at lowest point in line. Lay groove or bell end pointing upstream unless specifically noted otherwise.

D. Prepare trench bottom to design line and grade so that only minor movement of pipe is necessary after installation.

E. Inspect pipe for defects before carefully lowering into trench. Do not install damaged or defective pipe.

F. Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.

G. Do not lay pipe in water or on saturated soil or bedding, or allow water to rise in trench around pipe, unless approved by the Engineer.

H. Lay pipe to design line and grade.

I. Provide uniform bearing for full pipe barrel length.

1. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.

2. Do not block pipe above bedding unless flowable fill, controlled low strength material, concrete bedding, or concrete encasement is to be used.

J. Assemble joints as specified by pipe manufacturer.

K. Install cap, plug, or bulkhead at exposed ends of pipe whenever pipe installation is not in

progress.

L. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.

M. Cut ends of pipe at utility accesses and structures. Do not hammer cut or break pipe.

N. Install preformed wye or tee service fitting for each platted lot or building as shown on the plans.

O. Provide utility accesses where indicated on plans and as specified in Section 2403 of the Standard Specifications.

P. Correct misalignment, displacement, or otherwise defective pipe by removing, relaying or replacing pipe, at no additional cost to the Contracting Authority.

Q. Place water tight cap or plug at end of construction. Use manufactured material per approval of the Engineer or build in place per Figure 4010.2 on the plans.

3.04 PIPE JOINTING

A. Joint Cleaning: Clean joint surfaces with wire brush to remove soil or foreign material prior to jointing pipe.

B. Joint Assembly: Assemble joints in accordance with pipe manufacturer's recommendations.

1. Use equipment that does not apply damaging forces to pipe joints.

2. Use bar and block or internal or external jointing devices or other devices as recommended by pipe manufacturers.

C. Polyvinyl Chloride Pipe (PVC) and Polyvinyl Chloride Composite Pipe (PVC Truss):

1. Coat rubber gasket and joint with lubricant immediately prior to closing joint.

2. Seal ends of PVC truss and closed profile pipe at utility accesses with coating recommended by the manufacturer.

D. Reinforced Concrete Pipe (RCP):
Rubber O-ring flexible joint: Coat rubber ring gasket and joint with lubricant immediately prior to closing joint.

E. Ductile Iron Pipe (DIP):

1. Push-on Joint: Coat gasket and joint with lubricant immediately prior to closing joint.

2. Mechanical Joint: Wash plain end, bell socket, and gasket with soap solution, press gasket into socket, set gland, and tighten bolts uniformly.

F. Connections between Dissimilar Pipes:

1. Use manufactured adapters or couplings approved by the Engineer.

2. Where adapters or couplings are not available, the Engineer may authorize use of a Type II concrete collar as shown in Figure 4020.1A on the plans.

G. Lubricant for Joint Gaskets:

1. Soap-based only.

2. Do not use petroleum based lubricant.

3.05 SANITARY SEWER SERVICE STUBS

A. Provide sanitary sewer services as shown on the plans (see Figure 4010.1A).

B. Install wye or tee service fitting for each service connection according to Figures 4010.1A and 4010.1B on the plans.

C. Install riser pipe where sewer invert is 12 feet (3.6 m) or more below finished ground surface.

D. If riser is required, install wye branch or tee branch with a sewer service grade of 1.0% to 5% (see Figure 4010.1B on the plans).

E. Extend riser pipe up to 10 feet (3 m) minimum depth below finished ground surface. Plug unconnected end.

F. Connection of Sanitary Service to New Sewer Main:

1. Use only factory wye or tees, except for RCP.

2. Install according to the manufacturer's requirements and Sections 4010, 2.03 and 4010, 3.04 of this Developmental Specification for joints.

G. Use preformed saddle wye or saddle tee for service tap to existing sanitary sewer main.

1. Tap existing sanitary sewer main with a hole saw or sewer tap drill.

2. Use gasketed saddle with stainless steel clamps.

3. Install according to the manufacturer′s recommendations.

4. Prevent sanitary sewer service pipe from protruding into sanitary sewer main.

H. Extend building sanitary sewer from sanitary sewer main to a point 10 feet (3 m) outside of the right-of-way line or as shown on the plans (see Figures 4010.1A and 4010.1B on the plans).

I. Place water tight stopper, cap, or plug in end of sanitary sewer service.

J. Mark the end of the service line as required by the Engineer or as shown on the plans.

3.06 SANITARY SEWER SERVICE RELOCATION

Follow requirements of Section 4010 of this Developmental Specification.

3.07 TOLERANCES

A. Do not allow horizontal and vertical alignment of gravity sewer lines to vary from design line and grade at any point along the pipe by more than 1% of the inside diameter of the pipe or 1/4 inch (6.4 mm), whichever is larger.

B. Tolerance allowed for gravity sewer lines only if design line and grade is sufficient to prevent backslope when tolerance limits are reached.

C. Reverse slope on gravity pipe is prohibited. Remove and re-lay pipe to proper grade.

D. Do not allow horizontal and vertical alignment of force mains to vary from design line and grade by more than 3 inches (75 mm).

3.08 CONFLICTS

A. Provide temporary support for existing water, gas, telephone, power, or other utilities or services that cross trench.

B. Compact backfill under existing utility crossing as specified in Section 3010 of this Developmental Specification, or construct utility line supports where indicated on plans or as directed by the Engineer.

C. Separate gravity sewers from water mains by a horizontal distance of at least 10 feet (3m) unless:

1. Top of sewer is at least 18 inches (450 mm) below bottom of water main.

2. Sewer is placed in separate trench or in same trench on bench of undisturbed earth with at least 3 feet (900 mm) separation from water main.

D. Use ductile iron pipe as specified in Section 4010 of this Developmental Specification for gravity sewers with less than 10 feet (3 m) horizontal distance and top of sewer less than 18 inches (450 mm) below bottom of water main; maintain at least 2 feet (600 mm) linear separation.

E. Where gravity sewer crosses over water main or service, or where top of sewer is less than 18 inches (450 mm) below bottom of water main or service:

1. If physical conditions prohibit the separation, the sewer may not be placed closer than 6 inches (150 mm) below a water main or 18 inches (450 mm) above a water main. Use the maximum feasible separation distance in all cases.

2. Use 20 feet (6.1 m) length of ductile iron pipe as specified in Section 4010, 2.01 of this Developmental Specification for gravity sewer centered on water main.

3. The sewer and water main must be adequately supported and have watertight joints (see Figures 3010.4 to 3010.6 on the plans).

4. Backfill trench with low permeability soil for a length of 20 feet (6 m) centered on the crossing.

F. Separate sanitary sewer force mains from water mains by a horizontal distance of at least 10 feet (3 m) unless the force main is constructed of water main materials meeting minimum pressure rating of 200 psi (1380 kPa) and is installed at least 4 feet (1.2 m) horizontally from the water main.

SECTION 4020 - STORM SEWER

PART 3 - EXECUTION

3.03 PIPE INSTALLATION

A. Provide trench excavation, pipe bedding, and backfill as specified in Section 3010 of this

Developmental Specification.

B. Provide proper facilities for lowering the sections into place without damaging the pipe.

C. Begin at the lowest point in line. Lay groove or bell end point upstream unless specifically noted otherwise.

D. Prepare trench bottom to design line and grade so that only minor movement of pipe is necessary after installation.

E. Inspect pipe for defects before carefully lowering into trench. Do not install damaged or defective pipe.

F. Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.

G. Do not lay pipe in water or on saturated soil or bedding. Do not allow water to rise in trench around pipe.

H. Place pipe with lifting holes at the top of the pipe and fill lift hole with non-shrink grout or manufactured plugs.

I. Lay pipe to design line and grade.

J. Provide uniform bearing for full pipe barrel length.

1. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.

2. Do not block pipe above bedding.

K. Assemble joints as specified.

L. Protect exposed upstream ends of pipe to prevent soil sediment from entering storm sewer system with a watertight stopper, cap, or plug.

M. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.

N. Saw cut ends of pipe at utility accesses, intakes, and structures. Do not hammer cut or break pipe.

O. Provide utility accesses and intakes where indicated on plans and as specified in Section 6020 of this Developmental Specification.

SECTION 4030 - PIPE REHABILITATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Slip Lining Pipe.

B. Cured-in-Place Pipe Lining.

C. Formed-in-Place Pipe Lining.

D. Spot Repairs by Pipe Replacement.

1.02 DESCRIPTION OF WORK

A. Sewer Rehabilitation.

1. Pipe Lining:

a. Resin impregnated, cured in place pipe.
b. Deformed polyethylene for formed in place pipe.
c. Deformed polyvinyl chloride for formed in place pipe.
d. Slip lining.

2. Pipe spot repairs.

1.03 SUBMITTALS

A. Manufacturer′s instructions for installation of pipe liner and appurtenances.

B. Construction sequence.

C. Catalog data, samples, manufacturer′s data, and listing of applicable standards for special, unique, or proposed substitute materials if requested by the Engineer.

D. Contractor and material supplier must each certify that materials being provided meet requirements of this Developmental Specification or that alternate materials or substitutions have received written approval of the Engineer.

E. Project Record Documents.

F. Provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Obtain written approval of the Engineer for all substitutions prior to use.

B. Provide, as a minimum, the following information for evaluation.

1. Product Information.

a. Product name.
b. Year product first available in United States.
c. Total footage (meters) or number of line segments installed in United States.
d. Results of all available product testing, including but not limited to leakage, physical properties, pipe stiffness, chemical resistance, strain-corrosion, external loading, flow characteristics, infiltration/inflow reductions, structural capacity, and external hydrostatic loading capacity.
e. Samples of before and after product.
f. Design method.
g. Typical liner thickness for pipe sizes included in the project.

2. Manufacturer Information.

a. Manufacturer name.
b. Years experience manufacturing the product.
c. Country of manufacture of all product components.

d. Quality control procedures for product manufacture, including inspection requirements, testing procedures and allowable tolerance levels.
e. Related ASTM standards, or other nationally recognized standards for product manufacturing.

3. Installer Information.

a. Installer name.
b. Completed project list for last 5 years including for each project and year completed, client name/address/contact person/phone number, footages (meters) installed by pipe diameter and number of lateral reinstatements.
c. Detailed installation procedures, including estimated times for each task, lateral reinstatement methods, number of required excavations, and any other items unique to each product.
d. Video of installation process, if available.
e. Evidence of properly trained personnel.
f. Related ASTM standards or any nationally recognized standards for product installation.
g. Available equipment list.
h. Detailed procedures for repairing the product in the event of future damage or failure and for tapping future service connections, including required specialized equipment or training.
i. Videos of two rehabilitated sewer sections showing before and after conditions.
j. Additional information may be required. The submittal of prequalification information in no way implies that the product, manufacturer, or installer will be deemed to be qualified. The Contracting Authority, in its sole discretion, will determine whether a product, manufacturer, or installer does or does not qualify as an approved equal.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Load, transport, and unload pipe and appurtenances at project site.

B. Store materials and handle to avoid damage. Replace damaged materials. Remove damaged materials from site.

1.06 SCHEDULING

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations and verify clearance for proposed construction.

2. Complete elements of work that can affect line and grade in advance of other open cut construction unless noted on plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 PUBLIC RELATIONS PROGRAM

A. Establish a Public Information and Notification Program for contacting each home or business connected to the sanitary sewer and informing them of the work to be done, and when the sewer will be off-line and the following specific steps:

1. Written notice to be delivered to each home or business describing work, schedule, how it affects them, and a local telephone number of the Contractor that they can call to discuss the project or their problems.

2. Personal contact on the day of lateral verification with CCTV. Each lateral shall be verified by having the homeowner run water down their drain. If the homeowner is unavailable, other arrangements shall be attempted (cleanouts) to drain water through the lateral to verify each connection.

3. Written notice and attempted personal contact the day prior to beginning inversion of the section of sewer to which they are connected.

4. Personal contact with any home or business that cannot be reconnected within the time stated in the written notice.

5. If so required by any affected served business or homeowner, furnish and service portable toilets for use by the occupants.

6. The cost of these items will be considered to be incidental to the cost of the CIPP.

1.08 SPECIAL REQUIREMENTS

A. Notify the Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Prior to start of work, notify all affected parties 24 hours in advance as to length of time their service will be blocked.

C. Notify jurisdiction’s water works to use meter and pay for water, if required.

D. Contracting Authority will provide available VHS format video tapes to Contractor for use in pipe rehabilitation, as appropriate.

E. Contracting Authority will provide water for installation of cured-in-place pipe at a nearby hydrant. Use a separate valve mounted on hydrant.

1.09 MEASUREMENT FOR PAYMENT

A. Pipe Lining:

1. Pipe will be measured in feet (meters) along centerline of pipe liner in place.

2. Each size and type of pipe liner installed will be measured from center of utility access to center of utility access.

3. Payment will be made at the contract unit price for each type and size installed.

B. Building Sanitary Sewer Service Reconnection:

1. Each active existing building sanitary sewer service reconnected to liner pipe will be counted.

2. Includes services reconnected by excavating and reconnecting services or by trenchless reconnection methods.

3. Payment will be made at the contract unit price for each reconnection.

C. Intentionally Left Blank

D. Spot Repairs by Pipe Replacement:

1. The aggregate total of each type and size of pipe installed in linear feet (meters) will be measured along centerline of pipe. Reaches of 20 feet (6 m) or less shall be included in the lump sum contract unit price for the minimum length.

2. Pipe connection couplings, cutting of pipe to proper lengths, bedding, and backfilling will be considered incidental to spot repair.

3. Building sanitary sewer service connection will be paid under Section 4010 of this Developmental Specification.

4. Payment will be made at the contract unit price for each type and size of pipe installed.

PART 2 - PRODUCTS

2.01 POLYETHYLENE AND POLYOLEFIN MANUFACTURED PIPE FOR SLIPLINING

A. Pipe: Polyethylene (PE) or Polyolefin (PO):

1. Conform to ASTM D 1248, Type III, Class C, Category 5, Grade P 34 or equivalent ASTM D 3350 Cell Classification PE 335434C.

2. Maximum outside diameter and SDR as indicated on plans.

B. Joints:

1. Joined into continuous length on job site.

2. Butt joints fused according to the pipe manufacturer's recommendations with approved equipment and according to ASTM D 2657.

2.02 POLYVINYL CHLORIDE PIPE (PVC) MANUFACTURED PIPE 12 INCH TO 36 INCH (300 mm TO 900 mm) FOR SLIPLINING

A. Pipe:

1. Conform to ASTM F 949, minimum pipe stiffness, 46 psi (320 kPa).

2. PVC plastic meeting ASTM D 1784, Cell Classification 12454.

B. Joints: Gasketed joints meeting ASTM F 477 and ASTM D 3212.

2.03 POLYVINYL CHLORIDE PIPE (PVC) MANUFACTURED PIPE 21 INCH TO 48 INCH (525 mm TO 1200 mm) FOR SLIPLINING

A. Pipe:

1. Conform to ASTM F 1803, minimum pipe stiffness, 46 psi (320 kPa).

2. PVC plastic meeting ASTM D 1784, Cell Classification 12364.

B. Joints: Gasketed joints meeting ASTM F 477 and ASTM D 3212.

2.04 CENTRIFUGALLY CAST FIBERGLASS REINFORCED POLYMER MORTAR PIPE (CCFRPM) 18 INCH TO 48 INCH (450 mm TO 1200 mm) FOR SLIPLINING.

A. Pipe: Conform to ASTM D 3262.

B. Joints: Gasketed joints meeting ASTM D 4161.

2.05 RESIN-IMPREGNATED TUBE FOR CURED-IN-PLACE PIPE (CIPP)

A. Pipe:

1. Comply with ASTM F 1216.

2. One or more layers of flexible needled felt or equivalent non-woven material.

3. Stretch material to fit irregular pipe and negotiate bends.

4. Outside layer plastic coated with a translucent flexible material. No delamination of plastic coating.

5. Fabricated to a size when installed shall tightly fit length without joints.

6. Designed as per Equation X-1, ASTM F 1216.

B. Resin and Catalyst:

1. Unsaturated, styrene-based, thermoset resin and catalyst system or an epoxy resin and hardener that is compatible.

2. Cure in the presence of water with temperature in excess of 150°F (66°C).

3. Initial structural properties in accordance with ASTM F 1216;

CIPP PROPERTIES	ASTM TEST METHOD	MINIMUM VALUE*
Flexural Strength	D 790	4,500 psi (31 MPa)
Flexural Modulus of Elasticity	D 790	250,000 psi (1725 MPa)

* Minimum values shall be larger of these values or values indicated on plans.

C. Cured Pipe Dimensions:

1. Nominal internal diameter and length such that CIPP shall form to internal circumference

and length of original pipe.

2. Field verify diameter and length.

3. One continuous length without joints.

2.06 DEFORMED HIGH DENSITY POLYETHYLENE FOR FORMED-IN-PLACE PIPE (HDPE-FIPP)

A. Pipe:

1. Manufactured in deformed shape from high-density polyethylene pipe compound conforming to ASTM D 1248, Class C, Category 5 and Grade P 34.

2. Conform to long term hydrostatic strength rating of 1600 psi (11 MPa) or more according to ASTM D 2837.

3. Environmental stress crack resistance (ESCR) less than 2,000 hours in 100% solution, Igepal CO-630 at 100°C before failure according to ASTM D 1693, Condition C.

4. Minimum FIPP structural standards:

FIPP PROPERTIES	TEST METHOD	MINIMUM VALUE
Flexural Strength	D 790	3,300 psi (22.75 MPa)
Flexural Modulus of Elasticity	D 790	136,000 psi (938 MPa)
Tensile Strength	D 638	3,200 psi (22.1 MPa)

B. FIPP Dimensions:

1. Nominal internal diameter and length of existing pipe as indicated on plans.

2. Field verify diameter and length.

3. Outside diameter fabricated to fit tightly.

4. One continuous length without joints between utility accesses.

5. Minimum wall thickness required to meet Standard Dimension Ratio (SDR) as indicated on the plans.

2.07 DEFORMED POLYVINYL CHLORIDE FOR FORMED-IN-PLACE PIPE (PVC-FIPP)

A. Pipe:

1. Manufacture in deformed shape according to ASTM D 1784, Cell Classification 12454 B. Compounds with different cell classifications because one or more properties are superior to those specified are acceptable.

2. Performance requirements according to ASTM D 3034.

3. FIPP structural properties:

FIPP PROPERTIES	ASTM TEST METHOD	MINIMUM VALUE
Tensile Modulus of Elasticity	D 638	350,000 psi (2415 MPa)
Tensile Strength	D 638	6,000 psi (41.4 MPa)

B. FIPP Dimensions:

1. Nominal internal diameter and length of existing pipe as indicated on plans.

2. Field verify diameter and length prior to manufacturing.

3. One continuous length without joints between utility accesses.

4. Outside diameter fabricated to fit tightly.

5. Minimum wall thickness required to meet specified Standard Dimension Ratio (SDR) as indicated on plans according to ASTM F 1216.

2.08 PIPE REPAIR COUPLINGS FOR SPOT REPAIRS BY PIPE REPLACEMENT

See Figures 4030.1 and 4030.2 on the plans.

A. Style: Full circle, fully lined, bolted.

B. Length: 12 inches (300 mm), minimum.

C. Materials and Manufacturer:

1. Shells, armors, side bars, lugs, Turner lifting bars, bolts and nuts; stainless steel, Type 304, per ASTM A 240.

2. MIG welds, fully passivated.

3. Rubber gasket:

a. Full coverage.
b. Grid pattern.
c. Per ASTM D 2000, AA415.

4. Stainless steel armor bonded to gasket to bridge lug area.

D. Bolts: 1/2 inch or 3/8 inch (12.5 mm or 9.5 mm), Teflon coated threads.

2.09 SEWER MAIN PIPE (FOR SPOT REPAIRS)

A. Refer to Section 4010 of this Developmental Specification.

B. Use materials for pipe replacement as shown in the plans or approved by the Engineer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Conduct Public Relations Program.

B. Cleaning:

1. Clean soil, grit, debris, and obstructions prior to television inspection and/or insertion of liner pipe.

2. Remove materials and do not allow to pass to downstream sections.

3. Deposit material at an approved site.

C. Televising:

1. Furnish the Engineer with a standard VHS video tape of sewers while the flow is being bypassed before lining process and after lining process and service reconnections have been completed.

2. Provide on-tape numerical display of camera location, indexed from starting utility access, in feet (meters).

D. Service and Obstruction Location:

1. Coordinate and cooperate with the Engineer for service and obstruction location.

2. Locate the active sewer services by one of following:

a. Closed circuit televise service locations, breaks, obstructions, and structural failures by experienced personnel.
b. Insert sounding device through service, noting its location on ground surface.
c. Dye testing.

3.02 BYPASSING SEWAGE

A. Submit bypassing to the Engineer for review.

B. Plug line at a point upstream of pipe to be rehabilitated if bypassing required.

C. Pump flow to downstream point or adjacent system as directed by the Engineer.

1. Provide pump and bypass lines of adequate capacity to handle all flows.

2. Provide adequate reserve pumps on site for emergency use and for storm flows.

D. Do not allow damage to public or private properties.

3.03 OBSTRUCTIONS

A. Remove all obstructions.

B. If an obstruction is encountered which cannot be removed by methods operating within the pipe, excavate and remove obstruction upon approval of the Engineer.

C. Backfill, compact, and restore surface according to this Developmental Specification.

3.04 TEMPORARY SEWER SERVICE

A. If full normal sewer service is not re-established within the times stated, provide temporary facilities or hotel accommodations for affected residents and businesses.

3.05 SLIP LINING

A. Installation: Install according to the manufacturer's recommendations for liner pipe and ASTM F 585, unless noted otherwise.

B. Preliminary Work: Complete preliminary work as per Section 4030, 3.01, 3.02, 3.03, and 3.04 of this Developmental Specification before installation.

C. Excavation:

1. For slip lining insertions, excavate at or near one structure and work from the existing utility access at the other end of the section to be pulled.

2. Insert Pit:

- **a.** If one section of pipe is to be pushed or pulled at a time, dig evenly down to sewer similar to a jacking pit.
- **b.** If liner pipe is to be joined together above ground and pulled into sewer, dig pit length 12 times the inside pipe diameter and slope the pit end back to ground surface at 2.5 to 1.

D. Test Head:

1. Pull pulling head with one short section of liner pipe through sewer before inserting the liner used to test for taps or obstructions protruding too far into the sewer.

2. Attach cables to both ends of test head to allow for removal if an obstruction is encountered.

E. Liner: Pull or push liner into the host pipe according to ASTM F 585.

F. Service Reconnection:

1. Allow liner pipe to recover.

2. No sanitary service is to be left unconnected for more than 24 hours.

3. Complete reconnections involving excavation of service lines according to the jurisdictional plumbing codes.

4. Excavated liner reconnections are to be reconnected as per plumbing code except that the annular space between host pipe and slip liner pipe is to be filled with grouting process.

G. Grouting:

1. Before trimming the ends of pipe and sealing, allow for pipes to recover their original length. Time to be at least equal to time to pull liner into place.

2. Fill the space between liner and host pipe with Controlled Low Strength Material, Section

3010, 2.11, D of this Developmental Specification, or other material approved by the Engineer. Pump filler in from the lower end of the liner.

3.06 RESIN IMPREGNATED CURED-IN-PLACE PIPE (CIPP)

A. Install according to the manufacturer′s recommendations for this lining process and ASTM F 1216 unless noted otherwise.

B. Complete preliminary work as per Sections 4030, 3.01, 3.02, 3.03, and 3.04 of this Developmental Specification before installation.

C. Tube to be resin impregnated, hydraulically inverted in place with an approved lubricant, and cured in place as per ASTM F 1216, Section 7.

D. Continuous between utility accesses and may span several utility access reaches as allowed by the equipment, properties of CIPP, and size and condition of sewer.

E. Free of uncured spots, lifts (spots cured away from the sewer, and delaminations). Remove and replace.

F. Service Reconnections:

1. No sanitary service to be left unconnected for more than 24 hours.

2. Complete reconnections involving excavation of service lines according to the jurisdictional plumbing code.

3.07 DEFORMED HDPE OR PVC FORMED-IN-PLACE PIPE (FIPP)

A. Install according to the manufacturer′s recommendations for particular lining material and process, unless noted otherwise.

B. Complete preliminary work as per Sections 4030, 3.01, 3.02, 3.03, and 3.04 of this Developmental Specification before installation.

C. Liner Installation:

1. Designate location where insertion shall begin, subject to the Engineer's approval.

2. Transport FIPP to the site in continuous length on spools compatible with manufacturer′s designated process.

3. Heat FIPP material at job site as necessary for insertion. Pull FIPP into the sewer with appropriate pulling heads, cables, and heat distribution equipment.

4. FIPP to be continuous between utility accesses as allowed by tensile properties of FIPP and size and condition of sewer.

5. Connect fully inserted FIPP to heat source distribution equipment.

6. Round and expand by uniformly distributed heat, steam and pressure and by mechanical devices.

7. After FIPP has been expanded to a tight fit, cool gradually under pressure until process is complete.

8. To be continuous without joints over entire length.

9. Free of all material defects, no pits, pinholes, cracks, crazing, folds, or unrounded sections.

10. Repair any defects at no additional cost to the Contracting Authority.

D. Service Reconnections:

1. No sanitary service is to be left unconnected for more than 24 hours.

2. Complete reconnections involving excavation of service lines according to the jurisdictional plumbing code.

3.08 SPOT REPAIRS BY PIPE REPLACEMENT

A. Strip and stockpile topsoil and excavate at each location. Remove any pavement materials from the site. Use care to avoid damage to existing pipe.

B. Remove existing pipe to the extent required and disconnect affected sewer services.

C. Install replacement pipe of the same nominal size as existing. Use the same material as specified for Sanitary Sewers in Section 4010 of this Developmental Specification.

D. Temporarily support pipe at proper line and grade.

E. Reconnect sewer services.

F. Wrap all couplings with Polyethylene Wrap per Section 5010, 2.06 of this Developmental Specification.

G. Install Controlled Density Fill bedding per Section 3010 of this Developmental Specification.

H. Backfill trench per Section 3010 of this Developmental Specification.

I. Replace topsoil in grassed areas.

J. Replace pavement as directed.

K. See detailed drawings.

3.09 CLEANUP AND CLOSEOUT

A. Verify that services are reconnected and fully operable, with at least 90% of original capacity.

B. Submit initial and final video tapes to the Engineer.

C. Remove all equipment and debris.

SECTION 4040 - TESTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

Testing and inspection of sanitary sewers.

1.02 DESCRIPTION OF WORK

A. Test and inspect sanitary sewers, sanitary sewer force mains, and building sanitary sewers.

B. Test and inspect lined pipe.

1.03 SCHEDULING

A. Notify the Engineer when installation is complete and ready for testing.

B. Notify the Engineer at least 24 hours prior to performing testing.

C. The Engineer must be present to review testing procedures and to record results.

1.04 MEASUREMENT FOR PAYMENT

A. Video Inspection: Video Inspection of sewer lines will be measured and paid for on a lump sum basis or measured in lineal feet (meters) of sewer actually video inspected as specified in the contract documents. Payment will be at the contract unit price. Either method of payment shall be full compensation for all labor, tools, equipment, and materials necessary to complete the work. Provide the Engineer with a copy of all sewer video inspections. Any re-testing required for clarification by the Engineer shall be done at no additional cost to the Contracting Authority.

B. Testing and inspection of sanitary sewers and pipe rehabilitation is incidental to construction.

C. Include costs for testing and inspection in the contract unit prices for sewer construction and pipe rehabilitation.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT

A. Conform with applicable sections of ASTM.

B. Conform to other applicable industry standards and codes.

C. Video Inspection:

1. The video camera shall be high-resolution color with adjustable iris focus.

2. The camera shall have pan and tilt capabilities.

3. Lighting shall be suitable to allow proper illumination and a clear video image of the entire periphery of the pipe.

4. The video camera shall be able to operate in 100% humidity conditions.

5. The video camera and other video components of the video system shall produce a high quality video image.

6. The video inspection equipment shall be capable of displaying on-screen footage distance measured. The distance measured shall be accurate within 1%.

7. The inspection shall be recorded in color on a standard VHS videotape and/or on compact disc as required by the contract documents.

PART 3 - EXECUTION

3.01 CLEANING

A. Clean all sanitary sewers by flushing with water and by removing sheeting, bracing, shoring, forms, soil sediment, concrete, or other debris as directed by the Engineer prior to final acceptance.

B. Do not discharge soil sediment or debris to drainage channels or existing storm sewer or sanitary sewer systems.

3.02 VISUAL INSPECTION

A. Check each section of sanitary sewer by lamping.

B. Light should be visible through section of pipe lamped.

C. Visually inspect each section of pipe.

D. Repair or replace defective pipe or joints or remove and relay pipe not meeting alignment tolerances as directed by the Engineer.

3.03 VIDEO INSPECTION

A. Conduct video inspection of all new and rehabilitated sanitary sewers after all backfill and compaction operations are completed, but prior to paving.

B. Notify the Engineer 1 working day prior so they may be present during the inspection.

C. Inspection Procedure:

1. Prior to video inspection, clean the sewer to remove all debris and sediment. Run sufficient water through the pipe so as to saturate any potential low spots so that they may be detected during inspection.

2. Perform the inspection with closed circuit video equipment.

3. Begin the inspection at one end of the project and continue in the same direction until the inspection is complete.

4. Inspect all lateral connections and other observations at right angles utilizing the pan and tilt capabilities of the camera.

5. Center the video camera in the pipe during the inspection.

6. Limit video inspection to a rate of 30 feet (10 m) per minute.

D. Inspection Reporting:

1. Provide a copy of the video inspection, recorded in standard play speed, in color, on a 1/2 inch (12.5 mm) VHS videotape. Upon request from the Engineer, provide a copy of the video inspection on compact disc in addition to, or in lieu of, a VHS tape. The video recording shall include on screen continuous footages, pipe diameter, direction of viewing, and utility access and street location references. Affix labels to the tape or CD that include the name of the project, the date, and the location of the inspection.

2. Provide a written report of the inspection. In the report include true to scale drawings of

all sewer defects and observation locations. Ensure each line item entry on the written report references the VCR counter number.

E. Low spots (bellies) in excess of 1 inch (25 mm) for pipe diameters 18 inches (450 mm) or less and 5% of the pipe diameter for pipes 24 inches (600 mm) and larger will be considered unacceptable. If unacceptable low spots exist, as indicated by standing water during video inspection, remove and replace sewer as necessary and re-inspect.

3.04 SANITARY SEWER LEAKAGE

A. Maximum allowable infiltration or exfiltration for new sanitary sewer section including utility accesses is 200 gallons per inch of diameter per mile (19 L/mm of diameter/km) of pipe/day.

B. Test the sanitary sewer for infiltration or exfiltration as specified.

C. Test sanitary sewer utility accesses separately as specified in Section 6040 of this Developmental Specification.

3.05 SANITARY SEWER INFILTRATION TESTING

A. Use only where ground water is more than 2 feet (600 mm) above top of pipe at highest point in section being tested.

B. Provide documented verification of ground water elevations for not less than 24 hours before measurement of infiltration.

C. Measure infiltration in sanitary sewer with V-notch weir in downstream utility access.

3.06 SANITARY SEWER EXFILTRATION TESTING

A. Use an exfiltration test when ground water level is less than 2 feet (600 mm) above top of pipe at highest point in section being tested.

B. Sectionalize the test section so that internal pressure in pipe does not exceed 5 feet (1.5 m) of water.

C. Test Procedures:

1. Install a watertight plug in inlet of upstream and downstream utility access of sewer section being tested.

2. Fill sewer and upstream utility access with water until the water elevation in the upstream utility access is 2 feet (600 mm) higher than outside top of pipe in section being tested or 2 feet (600 mm) above existing ground water level, whichever is highest elevation.

3. Allow the water level to stabilize for 1/2 hour, then refill the upstream utility access with water to the original level and begin the test.

4. Measure the amount of water lost in the upstream utility access in 1 hour. Use that amount to determine exfiltration in a 24 hour period.

D. Exfiltration Rate: The following table may be used to determine exfiltration in gallons (liters) per 24 hours by measuring the loss that occurs in 1 hour. The table is applicable only for 48 inch (1.2 m) diameter utility accesses.

Loss in Gallons Per 24 Hours for Drop in Water Level Per Hour in 48 inch Diameter Utility Access										
DROP	**0”**	**1”**	**2”**	**3”**	**4”**	**5”**	**6”**	**7”**	**8”**	**9”**
		188	376	564	752	940	1128	1316	1504	1692
1/4”	47	235	423	611	799	987	1175	1363	1551	1739
1/2”	94	282	470	658	846	1034	1222	1410	1598	1786
3/4”	141	329	517	705	893	1081	1269	1457	1645	1833

Loss in Liters Per 24 Hours for Drop in Water Level Per Hour in 1200 mm Diameter Utility Access										
DROP	**0 mm**	**25 mm**	**50 mm**	**75 mm**	**100 mm**	**125 mm**	**150 mm**	**175 mm**	**200 mm**	**225 mm**
		712	1423	2135	2845	3558	4267	4982	5693	6405
6.3 mm	178	890	1601	2313	3025	3736	4448	5160	5871	6583
12.7 mm	356	1067	1779	2491	3202	3914	4626	5337	6049	6761
19.0 mm	534	1245	1957	2669	3380	4692	4864	5515	6227	6939

For utility accesses larger than 48 inch (1200 mm) diameter use the following formula:

ENGLISH

$G = 0.0816(H)(D^2)$

Where:
G = gallons drop in 24 hours in inches
D = diameter of utility access in inches
H = drop in utility access in inches

(METRIC)

$L = 353.25(D^2)$

Where:
L = liters drop in 24 hours in mm.
D = diameter of utility access in mm.
H = drop in utility access in mm.

3.07 SANITARY SEWER LOW PRESSURE AIR TESTING

A. A low pressure air test may be used in lieu of an exfiltration test except as noted.

B. The air test not recommended when ground water elevation is 2 feet (600 mm) or greater above the top of pipe and cannot be used when ground water is greater than 6 feet (2 m) above the top of pipe.

C. Use extreme care and follow safety precautions during testing operations. No one is allowed in utility accesses during testing.

D. Test Procedures:

1. Clean the entire line of all debris. Flush or wet line to produce consistent results.

2. Plug all inlets and outlets to resist the test pressure. Special attention must be given to stoppers and laterals.

3. Test duration. Determine test duration for section being tested from the table below. This table ignores pipe length and uses the factor 0.472d (1.20d), with d being in inches (mm). Pressure holding time is based on average holding pressure of 3 psi (21 kPa) gage or drop from 3.5 psi (24 kPa) to 2.5 psi (18 kPa) gage.

Size Pipe inches (mm)	Test Period Duration (Min.)
8 (200)	4.0
10 (250)	5.0
12 (300)	6.0
15 (325)	7.0
18 (450)	8.5
21 (525)	10.0
24 (600)	11.5
27 (675)	13.0
30 (750)	14.0
36 (900)	17.0
42 (1050)	20.0
48 (1200)	23.0
54 (1350)	25.5
60 (1500)	28.5

4. Add air to line segment being tested until the internal air pressure of the sewer line is raised to approximately 4.0 psi (28 kPa) gage greater than the average back pressure of any ground water that may be over the top of the pipe. Pressure in the sewer should not exceed 5 psi (35 kPa). Allow at least 2 minutes for air pressure to stabilize.

5. When pressure has stabilized and is at or above the starting test pressure of 3.5 psi (24 kPa) gage, commence the test. Record the drop in pressure for test period. The test may be discontinued when the prescribed test time has been completed, even though a 1.0 psi (7 kPa) gage drop has not occurred.

6. If groundwater level at time of testing is above the pipe invert, add 0.43 psig (9 kPa) gage air per foot (meter) of water above the invert to the test air pressure range of 2.5 psig (18 kPa gage) to 3.5 psig (24 kPa gage) stated above.

7. If the pressure drop exceeds 1.0 psi (7 kPa) gage during the test period, the test will be considered to have failed. Repair and retest the line.

3.08 SANITARY SEWER VACUUM TESTING

A. Vacuum testing may be used in lieu of other specified test methods.

B. Use extreme care and follow safety precautions during testing operations. Keep personnel out of and away from utility accesses during testing.

C. Where practical, clean pipe prior to testing and wet the pipe surface. Isolate the test segment as necessary, including closing service connections.

D. Test Procedures:

1. Determine the test time for the size of pipe being tested using the following Minimum Test Time Table.

2. Test time is the time required for vacuum to drop from 7 to 5 inches (180 mm to 130 mm) of mercury.

3. Minimum Test Time Table

Nominal Pipe	T (time)	Nominal Pipe	T (time)
4 (100)	0.3	21 (525)	3.0
6 (150)	0.7	24 (600)	3.6
8 (200)	1.2	27 (675)	4.2
10 (250)	1.5	30 (750)	4.8
12 (300)	1.8	33 (825)	5.4
15 (375)	2.1	36 (900)	6.0
18 (450)	2.4		

4. Use a vacuum pump with capacity to evacuate the sewer test section in time equal or less than that shown in Minimum Test Time Table for the size of pipe being tested.

5. Evacuate air until the internal air pressure of the sewer line is lowered by approximately 8 inches (200 mm) of mercury. Allow the air pressure to stabilize.

6. When the air pressure is stabilized near the starting test vacuum of 7 inches (180 mm) of mercury, commence the test by allowing gage pressure to drop to 7 inches (180 mm) of mercury, then commence time recording. Record the drop in vacuum for test period.

7. If the drop in vacuum is 2 inches (50 mm) of mercury or less during the test period, the test will be considered successfully passed.

8. If the drop in vacuum is greater than 2 inches (50 mm) of mercury during test period, inspect, evaluate, repair, and retest.

3.09 DEFLECTION TESTING

A. Perform deflection tests on all sanitary sewer flexible pipes, including PVC and PVC truss.

B. Perform deflection tests after backfill has been in place at least 30 calendar days and before paving activity takes place or as per these specifications.

C. Ensure pipe deflection does not exceed 5% of average inside diameter as established by ASTM Standards.

D. Pull approved 9-arm deflection mandrel through sewer by hand.

E. Approved mandrel must conform to applicable ASTM Standards.

F. Remove and replace pipe exceeding deflection limits.

G. Handle and divert existing flows during deflection testing.

3.10 FORCE MAIN TESTING

A. Clean force main as specified prior to testing.

B. Provide test pumps, test plugs, pipe and gages, and make necessary piping connections.

C. Fill force main with potable water and flush before test to remove entrapped air. Another water source may be used if approved by the Engineer.

D. Insert taps as required to remove air. Plug taps after the completion of tests.

E. Test pressure: 1.5 times the working pressure at lowest point along the test section but not less than 50 psi (350 kPa).

F. Pressurize the test section and allow it to stabilize prior to beginning the leakage test.

G. Pressurize the test section to the specified test pressure and maintain pressure to within 5 psi (35 kPa) of the test pressure by pumping in potable water as required.

H. Leakage is quantity of water that must be supplied into a test section to maintain pressure within 5 psi (35 kPa) of the specified test pressure during a 2 hour test period.

I. Maximum allowable leakage as determined by the following formula:

$$L = \frac{(S)(D)(P)^{0.5}}{133{,}200}$$

Where:
- L = allowable leakage in gallons per hour
- S = length of pipe tested in feet
- D = nominal pipe diameter in inches
- P = average test pressure in pounds per square inch (gage)

$$L = \frac{(S)(D)(P)^{0.5}}{705{,}150}$$

Where:
- L = allowable leakage in liters per hour
- S = length of pipe tested in meters
- D = nominal pipe diameter in mm
- P = average test pressure in kPa (gage)

J. Examine exposed pipe and fittings during test. Repair all visible leaks.

K. If the test indicates leakage greater than allowed, locate, repair or replace damaged or defective pipe, and repeat tests until the requirements are met.

DIVISION 5 - WATER MAINS AND APPURTENANCES

SECTION 5010 PIPE AND FITTINGS

PART 2 - PRODUCTS

2.03 FITTINGS

A. For Polyvinyl Chloride (PVC) Pipe:

1. AWWA C110 or AWWA C 153.

2. Joint Type:
- **a.** Use mechanical joint conforming to AWWA C 111 for pipe sizes 16 inches (400 mm) and less.
- **b.** For pipe sizes greater than 16 inches (400 mm), use restrained mechanical joint system. Provide follower gland using breakaway torque bolts to engage thrust restraint.
  - **1)** Minimum pressure rating of 250 psi (1725 kPa).
  - **2)** Suitable for buried service.
  - **3)** Provide stainless steel set screws on follower gland.
  - **4)** Joint restraint system to be field installable, field removable, and re-installable.

3. Cement mortar lined per AWWA C104 with asphalt coating.

4. Wall Thickness: AWWA C 153

5. Gaskets: Per AWWA C111

B. Fittings for Prestressed Concrete Cylinder Pipe: As required for prestressed concrete cylinder pipe.

C. Flange Adapter:

1. Body: Ductile iron conforming to the requirements of ASTM A 536.

2. End Rings (Follower Rings): Ductile iron conforming to the requirements of ASTM A 536.

3. Gaskets: New rubber compounded for water service and resistant to permanent set.

4. Bolts and Nuts: High strength, low alloy corrosion resistant steel or carbon steel bolts conforming to the requirements of ASTM A 307.

D. Pipe Coupling:

1. Center Sleeve (Center Ring): Steel pipe or tubing conforming to the requirements of ASTM A 53 or ASTM A 512, or formed carbon steel with a minimum yield of 30,000 psi (207 MPa).

2. End Ring (Follower Ring): ductile iron conforming to the requirements of ASTM A 536, or steel meeting or exceeding the requirements of ASTM A 576, grade 1010-1020.

3. Gaskets: New rubber compounded for water service and resistant to permanent set.

4. Bolts and nuts: High strength, low alloy corrosion resistant steel.

2.05 PIPELINE ACCESSORIES

Polyethylene Wrap:

1. Use on all ductile iron pipe and fittings in buried service.

2. Conform to AWWA C105.

3. Minimum thickness: 8 mil (200 µm).

DIVISION 6 - STRUCTURES FOR SANITARY AND STORM SEWER

SECTION 6020 - UTILITY ACCESSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Utility accesses for sanitary sewers.

B. Adjustment of existing utility accesses.

C. Connection to existing utility accesses.

D. Abandonment of utility accesses.

E. Existing utility access rehabilitation.

1.02 DESCRIPTION OF WORK

A. Construct sanitary sewer utility accesses, modify existing utility accesses, and abandon utility accesses where shown in the plans.

B. Rehabilitate existing utility accesses to water proof and prevent inflow and infiltration, prevent corrosion, or reestablish the structural integrity of the utility access. Includes construction of structural liners, protective liners, and chimney seals.

1.03 SUBMITTALS

A. Shop drawings showing compliance with this Developmental Specification.

B. Shop drawing schedule of new utility accesses showing total depth, relative elevations of all connecting sanitary sewer lines, all drops, and orientation of connecting lines.

C. Catalog cuts of iron castings, chimney seals, and sewer line connection gaskets.

D. Provide material certifications to the Engineer.

1.04 SUBSTITUTIONS

Obtain written approval of the Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

Store and handle materials to avoid damage. Replace damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by the Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete elements of the work that can affect line and grade in advance of other open cut construction unless noted on plans.

3. Notify the Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

Stop work and notify the Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

1.08 MEASUREMENT FOR PAYMENT

A. Utility Access: One of the following methods will be specified:

1. Utility Access by Lump Sum: The number of new utility accesses properly installed will be counted. Payment will be at the unit price for each type and size of utility access properly installed. The contract unit price for utility accesses shall include all excavation, bedding, backfill, compaction, concrete, reinforcing steel, and all appurtenances, including chimney seals, castings, and covers necessary for proper installation.

2. Utility Access by Vertical Feet: For new utility accesses properly installed, the number of combined base and casting units for each size and type will be counted. In addition, the utility access vertical dimension in feet (meters) from the flowline to the bottom of the casting will be measured. Payment will be at the contract unit price for each combined base and casting unit properly installed. In addition, payment will be made by the contract unit price for the vertical dimension of the utility access.

B. Drop Connection: The vertical feet (meters) of drop, from the flow line of the incoming sewer to the flow line of the drop at its entry into the utility access, will be measured for each size of sewer line. Payment will be at the contract unit price for vertical feet (meters) of drop per size of sewer line.

C. Casting Extension Rings: The number of existing utility casings raised with casting extension rings to match the elevation of a pavement overlay will be counted. Payment will be made at the contract unit price for each casting extension.

D. Utility Access Adjustment, Minor: Removal or additions of utility access adjusting rings will be considered incidental to utility accesses, unless otherwise specified as a contract item. If specified as a contract item, it will be at the contract unit price for each adjustment. If so specified, the number of utility accesses adjusted to finished grade by raising or lowering an adjustable casting or by addition or removal of utility access adjusting rings will be counted. Whether specified as a pay item or not, new casting is included.

E. Utility Access Adjustment, Major: The number of utility accesses adjusted to grade by addition or removal of utility access riser, cone or flat top sections, or the exchange of existing sections with sections having different vertical dimensions will be counted. Payment will be at the contract unit price for each major adjustment. The contract unit price shall include all excavation, bedding, backfill, compaction, concrete, reinforcing steel, and all appurtenances, including the new casting and new chimney.

F. Connection to Existing Utility Accesses: The number of connections made to existing utility accesses will be counted. Payment will be at the contract unit price for each connection.

G. Abandoned Utility Accesses: The number of utility accesses abandoned in place will be counted. Payment will be at the contract unit price for each abandoned utility access.

H. In Situ Utility Access Replacement, Formed-In-Place Concrete: The vertical dimension of In Situ Utility Access Replacement will be measured from the utility access invert to the bottom of the frame. Payment will be at the contract unit price per vertical foot (meter). When a plastic liner is specified, the installation will be measured and paid for separately from those without a liner. The contract unit price includes handling of sewer flows as required to properly complete the installation, bench and invert overlay as recommended by the manufacturer, and testing the utility access upon completion. In addition, the contract unit price for installations with a plastic liner includes sealing at the frame and cover and sealing pipe penetrations as recommended by the manufacturer.

I. Utility Access Lining with Centrifugally Cast Cementitious Mortar Liner with Epoxy Seal: For each liner thickness specified, the vertical dimension of utility access lining from the bottom of the lining to the top of the lining will be measured. Payment will be at the contract unit price per vertical foot (meter) for each thickness of liner properly installed. The contract unit price includes the handling of sewer flows during lining operations as required to properly complete the installation.

J. Install Chimney Seal on Existing Utility Access: The number of utility access chimney seals installed on existing utility accesses will be counted. Payment will be made at the contract unit price for each chimney seal installed.

PART 2 - PRODUCTS

2.01 CONCRETE UTILITY ACCESSE COMPONENTS

A. Concrete:

1. Precast: Comply with ASTM C 478.

2. Cast in place: Refer to Section 2403 of the Standard Specifications.

B. Riser Sections:

1. Inside Diameter: Use 48 inch (1200 mm) diameter riser or as shown in the contract documents.

2. Wall Thickness: See Figures 6020.1 to 6020.21 on the plans. For precast, see ASTM C 478.

3. Coating:

a. Exterior: When exterior waterproof coating is specified, provide bituminous or coal tar coating.

b. Interior: When utility access lining is specified, line according to lined, reinforced concrete pipe, Section 4010, 2.01 of this Developmental Specification.

4. Riser Joints:

a. Male and female ends.
b. Sanitary sewer utility access:

1) Rubber 'O' ring or profile gasket, flexible joint, per ASTM C 443.
2) Bituminous joint compound or butyl sealant wrap per ASTM C 877 to all exterior joints.

5. Lift Holes: Lift holes not to protrude through utility access wall. Provide non-shrink grout conforming to Materials IM 491.13, Appendix B, to cover lift hole plug and to fill joints.

C. Top Configuration:

1. Capable of supporting HS-20 loading.

2. Use eccentric cone, unless otherwise specified or allowed.

D. Base:

a. Type A (Standard) Precast Utility Access: Integral base and lower riser section in accordance with ASTM C 478.
b. All Other Utility Accesses: Cast in place concrete base.

E. Pipe Connection:

1. New Sanitary Sewer Utility Access:

a. Flexible, watertight gasket per ASTM C 923.
b. Install drop connection where required on plans. See Figure 6020.6A on the plans.
c. Use non-shrink grout conforming to Materials IM 491.13, Appendix B, on internal joint spaces.

2. Existing Sanitary Utility Access:

a. Cored or Drilled Opening: Provide a flexible, watertight connection that meets and/or exceeds ASTM C 923.
b. Knock Out Opening: See Figure 4020.1A on the plans.

F. Utility Access Steps:

1. Comply with ASTM 478.

2. Manufactured of polypropylene encased steel.

3. Uniformly space steps at 12 to 16 inches (300 mm to 400 mm).

4. Align with vertical side of eccentric top section.

5. First step no more than 36 inches (900 mm) from top of casting.

G. Utility Access Types:

Figure No.	Type	Description
6020.1	A	48 inch (1200 mm) minimum diameter riser with eccentric cone and integral base
6020.2	E	Cast in place box
6020.3	F	Combination cast in place utility access with 48 inch (1200 mm) diameter lower riser and eccentric cone
6020.4	I	48 inch (1200 mm) minimum diameter riser with eccentric cone and cast in place base for utility access placement on existing sewer
6020.5	J	48 inch (1200 mm) diameter riser with eccentric cone and T section

2.02 UTILITY ACCESS ADJUSTMENT RINGS (GRADE RINGS)

A. Use one of the following methods for grade adjustments of utility access frame and cover assemblies:

1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and free from cracks, voids, and other defects. Set concrete rings with asphalt mastic in trowelable or rope form.

2. High Density Polyethylene Grade Adjustment Rings:

Property	Test Method	Acceptable Value
Recycled Plastic	ASTM D 1248	N/A
Melt Flow Index	ASTM D 1238	0.3 to 30 g / 10 min. (1.1 to 113.5 L/10 min.)
Density	ASTM D 792	0.94 to 0.98 g / cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 psi (14 kPa to 34.5 MPa)

a. Tapered adjusting ring thickness ranges from 1/2 inch to 3 inches (12 mm to 75 mm).
b. Install grade adjustment rings on clean flat surfaces according to the manufacturer's recommendations with the proper butyl rubber sealant/adhesives.
c. Do not use polyethylene adjusting rings when they are exposed to HMA pavement.

B. Ensure the inside dimension of the adjustment ring is not less than the inside diameter of the utility access frame.

C. Construct utility accesses with at least one adjustment ring totaling 4 inches (100 mm) minimum and 12 inches (300 mm) maximum for new utility accesses and 4 inches (100 mm) minimum and 16 inches (400 mm) maximum for existing utility accesses.

2.03 CASTINGS (RING AND COVER)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Casting Types:

Figure No.	Casting Type	Ring/ Cover	Gasket	Bolted Cover (Floodable)	Typical Surface
6020.7	A	STD	Yes[1]	No	Non-paved/flexible[2]
6020.8	B	ADJ	Yes[1]	No	PCC[3]
6020.9	C	STD	Yes[1]	Yes	Non-paved/flexible[2]
6020.10	D	ADJ	Yes[1]	Yes	PCC[3]
[1]Maching bearing surfaces required.					
[2]Includes HMA, seal coat, gravel, and brick.					
[3]Includes castings in concrete boxouts.					

C. Utility Access Casting extension Ring:

1. Gray cast iron conforming to ASTM A 48, Class 35.

2. Size the extension ring to fit the existing ring and cover.

3. Maximum height of 3 inches (75 mm)

4. Match the dimensions of the existing ring and cover with an allowable diameter tolerance of -1/4 inch (6 mm) for the frame ridge and +1/4 inch (6 mm) for the cover recess.

5. The height of the extension ring as required to raise the top of the casting to make it level or no more than 1/4 inch (6 mm) below the finished pavement surface.

2.04 CEMENT MORTAR

Refer to Section 2403 of the Standard Specifications.

2.05 REINFORCING STEEL

Refer to Section 2403 of the Standard Specifications.

2.06 CHIMNEY SEAL (FOR NEW SANITARY SEWER UTILITY ACCESSES AND SANITARY SEWER UTILITY ACCESS ADJUSTMENTS)

A. External Rubber Seal:

1. Rubber Sleeve and Extension:

a. Corrugated, minimum thickness of 3/16 inch (4.75 mm), per ASTM C 923.
b. Minimum allowable vertical expansion of at least 2 inches (50 mm).
c. See Figure 6020.1, sheet 2, on the plans for dimensional requirements.

2. Compression Bands:

a. One piece band assembly to compress sleeve or extension against utility access and casting surfaces.

b. 16 gauge ASTM A 240, Type 304 stainless steel, minimum 1 inch (25 mm) width, minimum adjustment range of 4 inches (100 mm) more than the utility access outside diameter.
c. For standard two piece castings, top band shaped to lock sleeve to utility access frame's base flange. For three piece adjustable castings, top band shaped to lock sleeve to upper piece of adjustable frame.
d. Stainless steel fasteners conforming to ASTM F 593 and 594, Type 304.

B. Internal Rubber Seal:

1. Rubber sleeve and extension:

a. Double pleated, minimum thickness 3/16 inch (4.75 mm) thick, per ASTM C 923.
b. Minimum allowable vertical expansion of at least 2 inches (50 mm).
c. Integrally formed expansion band recess top and bottom with multiple sealing fins.
d. See Figure 6020.1, sheet 2, of the plans for dimensional requirements.

2. Expansion Bands:

a. One-piece band assembly to compress sleeve or extension against utility access and casting surfaces.
b. 16 gauge ASTM A 240, Type 304 stainless steel, minimum 1 3/4 inch (44 mm) width, minimum adjustment range of 2 inches (50 mm) more than the utility access inside diameter.
c. Locking mechanism of studs and nuts to be stainless steel conforming to ASTM F 923 and F 594, Type 304.

2.07 INVERT

A. Construct utility access up to one half of pipe diameter to produce a smooth half pipe shape between pipe inverts. Slope invert bench toward pipe 1/4 inch per foot (21 mm/m) perpendicular to flow line.

B. Use a precast invert on all precast base sections, unless otherwise allowed by the Engineer. See Figure 6020.1 on the plans.

2.08 UTILITY ACCESS REHABILITATION

A. Chimney Seals (For Utility Access Rehabilitation):

1. Rubber chimney seals as specified in Section 6020, 2.06 of this Developmental Specification.

2. Brush Applied Urethane Chimney Seal:

Property	Test Method	Acceptable Value
Elongation	ASMT D 412	800%, minimum
Tensile Strength	ASTM D 412	1150 psi (8 MPa), minimum
Adhesive Strength	ASTM D 903	175 lb/in, (3 kg/mm)
Pressure Resistance	ASTM C 1244	2 minutes

B. Utility Access Interior:

1. In Situ Utility Access Replacement, Formed-In-Place Concrete:

a. Forming System: Provide an internal forming system capable of forming a new and structurally independent utility access wall within the existing utility access, with the specified thickness and conforming to the general shape of the existing utility access.

b. Concrete: Type I/II PCC with 5/8 inch (16 mm) minus coarse aggregate with fiber reinforcement and water reducer, 4000 psi (27.5 MPa) minimum 28 day compressive strength.

c. Plastic Liner: When specified, provide a PVC or PE plastic liner resistant to degradation by sulfuric acid. The liner shall be capable of being attached to the exterior of the forming system during erection of the forms. Use a plastic liner with a ribbed or studded exterior surface suitable for anchoring to the newly formed interior wall.

2. Centrifugally Cast Cementitious Mortar Liner with Epoxy Seal:

a. Cementitious Lining:

1) High strength, high build, corrosion resistant mortar, based on Portland cement fortified with micro silica. Mixed mortar to have a paste-like consistency which may be sprayed, cast, pumped, or gravity-flowed into any area 1/2 inch (15 mm) and larger.

2) Exhibits the following properties:

Property	Value
Unit Weight	125 pcf (2Mg/m^3)
Set Time at 70°F (21°C) ASTM C 403 Initial Set / Final Set	240 minutes / 440 minutes
Modulus of Elasticity ASTM C 469 24 hours / 28 days	180,000 psi / 1,150,000 psi (1240 MPa / 7900 MPa)
Flexural Strength ASTM C 293 24 hours / 28 days	650 psi / 800 psi (4.5 MPa / 5.5 MPa)
Compressive Strength ASTM C 109 24 hours / 28 days	3,000 psi / 10,000 psi (20.7 MPa / 69 MPa)
Tensile Strength ASTM C 307	600 psi (4.1 MPa)
Shear Bond ASTM C 882	>1,000 psi (>6.9 MPa)
Shrinkage ASTM C 157	None
Chloride Permeability ASTM C 1202	<550 Coulombs

3) Contains a liquid admixture for the prevention of micro biologically induced corrosion. The admixture permeates the mortar during the mixing phase and

molecularly bonds to the cement particles, creating an environment incompatible to the growth of bacteria that may be harmful to concrete.

b. Corrosion Resistant Epoxy Lining:

1) Consists of a two-component 100% solids epoxy design formulated for use in sewer systems. The epoxy lining forms a protective layer impervious to biological corrosion.

2) Physical Properties:

Property	Value
Dry Time	4-6 hours at 75°F (24°C)
Compressive Strength ASTM D 695	16,800 psi (116 MPa)
Flexural Strength ASTM D 790	13,900 psi (96 MPa)
Tensile Strength ASTM D 638	12,400 psi (85.5 MPa)
Hardness ASTM D 2240	68-72 Shore D
Heat Distortion ASTM D 648	220°F (104.4°C)
Ultimate Elongation ASTM D 638	4.5 %
Adhesive Shear ASTM C 882	1,000 psi (6.9 MPa)

PART 3 - EXECUTION

3.01 UTILITY ACCESS INSTALLATION

A. Excavation: Excavate according to Section 3010 of this Developmental Specification.

B. Subgrade Preparation:

1. Undisturbed soil: Hand grade to accurate elevation.

2. Disturbed soil: Machine compact to 95% of maximum Standard Proctor Density and hand grade to accurate elevation or install stabilization material as directed by the Engineer.

C. Installation of Cast in Place Base:

1. Excavate and prepare subgrade to the required elevation to accommodate the cast in place base.

2. Place Class C concrete base as specified.

3. Embed lower riser section in base concrete a minimum of 3 inches (75 mm).

4. Ensure proper vertical and horizontal alignment of base riser section.

D. Installation of Precast Base with Base Riser Section:

1. Excavate and prepare subgrade to the required elevation to accommodate the aggregate subbase.

2. Place aggregate subbase as specified.

3. Place base with lower riser section and ensure vertical and horizontal alignment.

E. Additional Risers Sections: Install additional riser sections as required.

F. Repairs: Repair all honeycomb areas or damaged areas as directed by the Engineer.

G. Pipes: Install and bed pipes. Place bedding and pipe embedment material according to Section 3010 of this Developmental Specification.

H. Lift Holes: For sanitary sewers, install rubber plug and grout over manhole lift holes.

I. Utility Access Invert: Install utility access invert if not precast. If precast, remove all projections and repair all voids to ensure a hydraulically smooth channel between pipe ends.

J. Top Sections: Install utility access cone or flat top section.

K. Utility Access Adjustment Ring(s): Bed each concrete ring with cold-applied bituminous jointing compound. Bed each polyethylene ring with manufacturer's approved product. Use a minimum stack height of 4 inches (100 mm) and a maximum adjustment ring stack height of 12 inches (300 mm). For greater adjustment, modify lower riser section(s).

L. Utility Access Ring and Cover: Install utility access ring and cover and accurately adjust to proper grade. Where utility access is to be in a paved area, adjust slope to match finished surface.

M. Chimney Seal: On sanitary sewer utility accesses, install internal or external rubber chimney seal meeting the requirements of Section 6020, 3.04 of this Developmental Specification.

N. Utility Access Joint Sealant: Apply bituminous joint compound or butyl sealant wrap to exterior of sanitary sewer utility access joints. If required, apply engineering fabric wrap meeting the requirements of Article 4196.01, B of the Standard Specifications.

O. Backfill and Compaction: Place and compact per Section 3010 of this Developmental Specification. Use extra care to ensure proper and uniform compaction of backfill around structure.

3.02 CONCRETE, REINFORCEMENT, AND PLACEMENT

Refer to Section 2403 of the Standard Specifications.

3.03 MODIFICATION OF EXISTING UTILITY ACCESSES

A. Casting Extension Rings: Install and adjust for proper alignment.

B. Minor Adjustment (adding or removing adjusting rings): adjustment by adding or removing adjusting rings:

1. Remove casting.

2. As necessary, add a maximum height of 16 inches (400 mm) of adjustment rings to adjust existing utility access to finished pavement grade or finished topsoil grade. Bed each ring with cold applied bituminous jointing material. Bed each polyethylene ring with manufacturer's approved product.

3. Remove one or more adjustment rings, as appropriate to reduce casting elevation.

4. Replace casting. Install new frame and cover on modified adjusting ring.

5. Replace chimney seal for sanitary sewer utility accesses using only new materials.

6. Refer to Section 2301 of the Standard Specifications for additional utility access adjustment requirements in pavement.

C. Major Adjustment (adding or removing riser or cone sections):

1. Remove castings.

2. Remove top.

3. Remove and replace riser section and/or top section, as appropriate.

4. Replace casting. Install new frame and cover

5. Fasten utility accesses to castings with bolts.

6. Replace chimney seal for sanitary sewer utility accesses using only new materials.

D. Connection to Existing Utility Accesses:
Unless otherwise specified in the contract documents, or approved by the Engineer, core all new openings in existing utility accesses.

1. Excavate as appropriate. Mark utility access barrel for point of insertion of added sewer line.

2. Divert flow as necessary. Obtain the Engineer's approval for the diversion plan. Maintain sewer service at all times unless otherwise permitted by the Engineer.

3. Carefully core out opening to utility access. Remove existing utility access invert as necessary to install pipe at required elevation and develop hydraulic channel.

4. Cored opening:

- **a.** Insert flexible watertight connector into new opening.
- **b.** Install and tighten internal expansion sleeve to hold flexible connector in place.
- **c.** Insert pipe through flexible connector and tighten external compression ring.
- **d.** Do not grout opening or pour collar for cored opening with flexible connector.

5. Cut and chipped opening (knockout):

- **a.** When allowed, refer to Figure 6020.21 on the plans.
- **b.** Install waterstop around outside of pipe. Secure in place.
- **c.** Position end of pipe flush with interior wall of utility access and with waterstop located within wall opening.
- **d.** Grout opening between utility access wall and outside of pipe with non-shrink grout.
- **e.** Pour concrete collar around pipe and exterior utility access opening as shown on Figure 6020.21 on the plans.

6. Reconstruct utility access invert.

7. Bed pipe and place backfill per Section 3010 of this Developmental Specification.

3.04 CHIMNEY SEALS

A. Install chimney seals on all sanitary sewer utility accesses

B. Rubber Chimney Seals (see Figure 6020.1, sheet 2, on the plans):

1. Do not install external chimney seal if utility access is exposed to sunlight.

2. Install seals on a smooth sealing surface.

3. All seals extend to 3 inches (75 mm) below the lowest adjusting ring.

4. For standard two piece castings, seals to extend 2 inches (50 mm) above the flange of the casting. For adjustable three piece castings, seals to extend 2 inches (50 mm) above the top of the base section of the casting.

5. Use multiple seals, if necessary.

6. Install compression bands (external chimney seal) or expansion bands (internal chimney seal) to lock the rubber sleeve or extension into place and to provide a positive watertight seal. Once tightened, lock the bands into place. Use only manufacturer recommended installation tools and sealants.

C. Flexible Urethane Seal:

1. Use only for utility access rehabilitation, if specified.

2. Prepare the surface according to the manufacturer's recommendations, including sandblasting, pressure washing, sealing leaks or gaps, and drying surface.

3. Apply primer, prepare product, and brush apply a flexible urethane seal to a minimum thickness of 175 mils (5 mm), covering 2 inches (50 mm) above the bottom of the frame and the entire adjustment ring area to 3 inches (75 mm) below the bottom adjustment ring.

3.05 ABANDONED UTILITY ACCESSES

A. Unless specified otherwise, remove top and walls of structure to a minimum of 10 feet (3 m) below subgrade in paved areas or 10 feet (3 m) below finish grade in other areas.

B. Plug all pipes in structure using 3,000 psi (20.7 MPa) concrete.

C. Fill remaining structure using flowable mortar per Section 3010 of this Developmental Specification.

D. Place compacted earth fill over structure as required for embankment or compacted backfill.

3.06 UTILITY ACCESS TESTING

Comply with Section 6040 of this Developmental Specification.

3.07 UTILITY ACCESS REHABILITATION

A. Utility Access Chimney.

Install utility access chimney seal according to Section 6020, 3.04 of this Developmental Specification.

B. Utility Access Interior.

1. In Situ Utility Access Replacement, Formed-In-Place Concrete: Prepare, install and test according to the forming system manufacturer's recommendations including:

a. Preparation:

1) Clean existing surface to remove loose material and debris.
2) Remove existing steps that might interfere with the erection of the forms.
3) Control infiltration that may affect placement of concrete.

b. Installation:

1) Place pipe extensions through structure to maintain flow during installation.
2) Erect forms inside utility access. Include plastic liner when specified.
3) Bolt the assembled internal forms together to prevent shifting and provide sufficient stiffness and strength to prevent collapsing.
4) Seal forms at the bottom of the utility access to ensure concrete does not enter the sewer.
5) Carefully place concrete between forms and existing utility access walls. Place concrete from bottom up to prevent segregation of concrete.
6) Consolidate concrete as required to fill all pockets, seams and cracks within the existing utility access wall.
7) Remove forms when concrete has cured sufficiently
8) If plastic liner is installed, weld and test joints.
9) Apply sealing strip around the circumference of the invert bench where it meets the vertical wall and around all pipe penetrations, to form a waterstop.
10) Overlay the invert bench with concrete or high strength mortar at a thickness of 3 inches (75 mm) at the wall, tapering to 1/2 inch (13 mm) at the edge of the invert.
11) Apply a 100% solid epoxy to the invert bench for corrosion resistance. Apply clean sand to epoxy to create a non-slip surface.
12) Seal the plastic liner to the utility access casting and existing pipe stubs as recommended by the manufacturer.

2. Centrifugally Cast Cementitious Mortar Liner with Epoxy Seal:

a. Surface Preparation: Prepare the surface according to the manufacturer's recommendations, including washing the interior with a high-pressure washer and plugging ~~any~~ active leaks with the appropriate plugging material.

b. Mortar Application: Apply according to the manufacturer's recommended procedures including the following items:

1) Apply with a rotating centrifugal casting applicator, beginning at the bottom of the utility access.
2) Retrieve the applicator head at the manufacturer's recommended speed to achieve the desired thickness.
3) Apply to full required thickness utilizing multiple passes as necessary. Minimize time between passes so that subsequent passes are cast against fresh mortar.
4) Verify thickness with a wet gage at several locations to ensure proper depth.

5) Brushing the mortar after application to improve adhesion is optional.
6) Hand apply additional material to the invert bench surface at a thickness of 3 inches (75 mm), tapering from the wall to the edge of the channel.

c. Epoxy Seal Application: Apply according to the manufacturer's recommended procedures including the following:

1) Apply with rotating centrifugal casting applicator or airless sprayer onto the fresh mortar liner.
2) If epoxy seal is applied more than 24 hours after application of the mortar lining, or if the mortar lining is exposed to foreign matter, rinse to neutralize its surface and then apply the epoxy.

SECTION 6040 - TESTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

Testing and inspection of utility accesses, intakes, and other utility structures.

1.02 DESCRIPTION OF WORK

Test and inspect sanitary sewer utility accesses and other utility structures.

1.03 SCHEDULING

A. Notify the Engineer when installation is complete and ready for testing.

B. Notify the Engineer at least 24 hours prior to performing testing.

C. The Engineer must be present to review testing procedures and record results.

D. Provide material certifications to the Engineer.

1.04 MEASUREMENT FOR PAYMENT

Include costs for testing in the contract unit prices for utility accesses, intakes, and utility structures except as specified in Section 2403 of the Standard Specifications.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT

A. Conform to applicable sections of ASTM.

B. Conform to other applicable industry standards and codes.

PART 3 - EXECUTION

3.01 CLEANING

A. Clean all utility accesses, intakes, and structures by removing sheeting, bracing, shoring, forms, soil sediment, concrete waste, and other debris as directed by the Engineer.

B. Do not discharge soil sediment or debris to drainage channels or existing storm sewer or sanitary sewer system.

3.02 VISUAL INSPECTION

A. Examine Structure For:

1. Damage.

2. Slipped forms.

3. Indication of displacement of reinforcement.

4. Porous areas or voids.

5. Proper placement of seals, gaskets, and embedments.

B. Verify that structure is set to true line, grade, and plumb.

C. Verify structure dimensions and thicknesses.

3.03 REPAIR

A. Repair or replace any unacceptable work at no additional cost to Contracting Authority.

B. Repair all visible leaks.

C. Remove concrete webs or protrusions.

D. Remove form ties and repair tie holes.

E. Refer also to Section 2403 of the Standard Specifications.

3.04 SANITARY SEWER UTILITY ACCESS TESTING

A. Method of Test. Subject to the Engineer's approval.

B. Provide all necessary equipment, supplies, and labor to complete required testing.

C. Preliminary test. Conduct preliminary test prior to backfilling utility access, unless waived by the Engineer. Make indicated repairs and adjustments.

D. Conduct final test after utility access construction is complete, all repairs and connections have been made, and invert has been installed.

E. Refer to Iowa Wastewater Facilities Design Standards, Chapter 12, Iowa Standards for Sewer Systems, by Iowa Department of Natural Resources.

F. Infiltration Test: Not allowed for utility access testing.

G. Low Pressure Air Test: Not allowed for utility access testing.

H. Vacuum Test:

1. Applicable only for new utility accesses isolated from connecting sewer lines.

2. Perform preliminary test after utility access construction is completed and prior to backfilling.

3. Perform final test after backfilling is completed.

4. Use manufactured vacuum test equipment meeting the Engineer's approval. Follow the equipment manufacturer's recommended procedures throughout.

5. Use extreme care and follow safety precautions during testing operations. Keep personnel clear of utility accesses during testing.

6. Seal all openings except utility access top access using pneumatic plugs rated for test pressures. Install plugs according to the test equipment manufacturer's recommendations.

7. Brace pipe inverts if connecting pipes have not been backfilled.

8. Install the vacuum tester head assembly on utility access top access, and inflate the seal.

9. Evacuate the utility access to 10 inches (250 mm) Hg (mercury) or 5 psi (35 kPa), close the isolation valve and start the test. Record the starting time.

10. Maintain vacuum in the utility access for the time indicated in the table below for the diameter and depth of utility access being tested.

11. Allowable vacuum loss: 1 inch (25 mm) Hg.

12. Test failure is indicated by vacuum loss greater than allowable within the minimum test time indicated in the table below for the size of utility access being tested.

Minimum Test Times for Various Utility Access Diameters					
Depth, Feet (m)	**Diameter, inches (mm)**				
	48 (1200)	**54 (1350)**	**60 (1500)**	**66 (1650)**	**72 (1825)**
	Time, Seconds				
8 (2.45)	20	23	26	29	33
10 (3.28)	25	29	33	36	41
12 (3.66)	30	35	39	43	49
14 (4.27)	35	41	46	51	57
16 (4.88)	40	46	52	58	67
18 (5.49)	45	52	59	65	73
20 (6.10)	50	53	65	72	81
22 (6.71)	55	64	72	79	89
24 (7.32)	59	64	78	87	97
26 (7.93)	64	75	85	94	105
28 (8.54)	69	81	91	101	113
30 (9.15)	74	87	98	108	121

I. Exfiltration Test:

1. Applicable for new or rehabilitated utility accesses.

2. Testing may be performed in conjunction with sanitary sewer lines. Refer to Section

4040 of this Developmental Specification.

3. Do not test by this method if temperature of components is below 33°F (0.5°C).

4. Plug both the inlet and outlet.

5. Hydraulic head for testing: Fill the utility access with water to 2 feet (600 mm) above the outside top of the connecting pipe, but not less than 2 feet (600 mm) above nor more than 5 feet (1500 mm) above ground water level.

6. Mark the water level.

7. Allow water to stand in the utility access for 1 hour, then refill to the original water level and begin the test.

8. After 1 hour, measure the drop in water level. For a 48 inch (1200 mm) diameter utility access, compare the measured water level drop to the table in Section 4040, 3.06 D of this Developmental Specification to determine the equivalent gallons (liters) lost per 24 hours. For other utility access sizes, calculate the 24 hour equivalent loss using the formula stated therein.

9. Maximum allowable exfiltration (leakage) per 24 hours: Refer to Section 4040, 3.04 of this Developmental Specification.

10. Test failure is indicated by water loss greater than maximum allowable exfiltration.

3.05 TEST FAILURE

A. If test fails, reseal openings, repair utility access, and retest. An alternate test method conforming to this specification may be used for a retest if desired.